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(54) **METHOD AND DEVICE FOR MEASURING THE PROGRESS OF A MOVING PERSON**

VERFAHREN UND VORRICHTUNG ZUR MESSUNG DES FORTSCHREITENS EINER SICH BEWEGENDEN PERSON

PROCÉDÉ ET DISPOSITIF PERMETTANT DE MESURER LA PROGRESSION D'UNE PERSONNE EN MOUVEMENT

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(56) References cited:
EP-A1- 0 119 009 **EP-A1- 1 199 544**
EP-A2- 1 058 091 **WO-A1-01/25726**
WO-A1-99/18480 **WO-A1-99/44016**
WO-A1-2005/004719 **WO-A1-2007/017471**
US-A- 5 583 776 **US-A1- 2003 191 582**
US-A1- 2003 191 582 **US-A1- 2004 064 286**
US-A1- 2007 062 279 **US-A1- 2007 073 514**
US-A1- 2007 143 068

- **ROBERTSON D ET AL: "DESIGN AND RESPONSES OF BUTTERWORTH AND CRITICALLY DAMPED DIGITAL FILTERS", JOURNAL OF ELECTROMYOGRAPHY AND KINESIOLOGY, vol. 13, 1 January 2003 (2003-01-01), pages 569-573, XP008167678, ISSN: 1050-6411, DOI: 10.1016/S1050-6411(03)00080-4**
- **PERRIN O ET AL: "IMPROVEMENT OF WALKING SPEED PREDICTION BY ACCELEROMETRY AND ALTIMETRY, VALIDATED BY SATELLITE POSITIONING", MEDICAL AND BIOLOGICAL ENGINEERING AND COMPUTING, SPRINGER, HEILDELBERG, DE, vol. 38, no. 2, 1 March 2000 (2000-03-01), pages 164-168, XP000913394, ISSN: 0140-0118, DOI: 10.1007/BF02344771**
- **WILKINSON R H: "HIGH-FIDELITY LOW-PASS FINITE-IMPULSE-RESPONSE FILTERS", JOURNAL OF GUIDANCE AND CONTROL AND DYNAMICS, AIAA, RESTON, VA, US, vol. 12, no. 3, 1 May 1989 (1989-05-01), pages 412-420, XP001121537, ISSN: 0731-5090**

EP 2 165 203 B1

Description

Field of the invention

[0001] The invention relates to measuring devices for use in physical measuring, and more specifically to a method and a device for measuring the progress of a moving person. The invention aims at providing a solution, better and simpler than prior ones, for measuring the progress of a moving person, which solution is applicable for use in a multitude of measuring solutions for different types of locomotion.

Background of the invention

[0002] In performing navigation based on inertia sensors, e.g. acceleration or angular velocity sensors, (inertia navigation), if the sensor signal is being integrated, it is important that the integration time is not extended too much, thus excessively increasing the error in position or direction caused by measuring errors of the sensor. In order to prevent that, the aim often is to divide the motion into periodically repetitive cycles of sufficient brevity. The method is called step-by-step navigation. In athletics coaching and competitions and in fitness exercise and other outdoor activities, such step-by-step navigation is important, wherein e.g. the speed of locomotion, the distance covered, the direction, the step rate (cadence), and the step time, as well as the step length are being measured. The way of locomotion could be e. g. running, walking, pole walking, competitive walking, cross-country skiing, downhill sports, roller skiing, roller-skating, skating or the like, where a cyclic motion is present.

[0003] Inertia navigation can work independently, or it can be used in combination with satellite navigation, in order to improve the accuracy of satellite navigation, particularly in areas of poor coverage of the satellite signal, for diagnostic purposes in satellite positioning error situations, or in order to reduce the power consumption of satellite navigation by means of increasing the intervals between instances of reception of the satellite signal.

[0004] In prior art, several solutions exist aiming at measuring the distance covered by using an acceleration sensor. In inertia navigation, for example, an acceleration sensor is most often used for measuring the distance covered. By means of the acceleration sensor, the contact time for the foot, i.e. the time during which the foot touches the ground, can be measured. For instance, the US Patent Publication US 4,578,769 discloses such a solution according to prior art. The method described in said Patent Publication provides good results for high running speeds, but it is not robust for slow running, nor for walking, where the event of the foot leaving the ground is hard to detect.

[0005] The acceleration sensor can be a simple switch or the like, which simply counts the number of steps and estimates the distance based on the number of steps, and the speed based on the cadence. These devices are called pedometers.

[0006] As a solution in a slightly more advanced system according to prior art, the actual motion of the walker can be measured at the foot by means of an acceleration sensor. Such solutions according to prior art are disclosed in e.g. the US Patent Application US 2002/0040601, the US Patent Publication US 5,955,667 and in the Canadian Patent Publication CA 2,218,242.

[0007] In the aforementioned patent publications, measuring signals from a multitude of acceleration sensors and angular motion sensors are combined, and significantly improved precision is achieved compared to the one for pedometers or contact time measurements. In these solutions according to prior art, the drawbacks, however, are the required number of sensors, a linear acceleration sensor as well as an angular motion sensor, for compensating the error caused by the earth's gravitational force, through the inclination and its variation, as well as the complexity of the algorithm, which manifest themselves in the size of the system, its costs, and power consumption.

[0008] In order to simplify the measuring system described above, a solution according to prior art has been disclosed, for using an acceleration sensor in such a way, that knowledge of the period of time the foot stays immobile, as it is on the ground, is being utilized and thus, the aim has been to improve the precision through automatic resetting. A solution according to prior art with such a technique is disclosed in e.g. US Patent Publication US 6,356,856. The method described in said Patent Publication suffers, however, from inaccuracy, when the inclination changes during the motion. Computing is complex in this case as well, and it requires power and program storage capacity.

[0009] One solution according to prior art, for detecting motion and for measuring the duration of movement is a disclosed method based on an acceleration sensor. Such a prior art solution is disclosed, for example, in the US Patent Publication US 6,298,314.

[0010] One further solution according to prior art, for a general device for measuring the movement of an athlete is disclosed, for example, in US Patent Publication US 7,092,846 and in the International Patent Application Publication WO 00/20874.

[0011] Document US2007/073514 A1 discloses a walking analyzer with an acceleration sensor that detects an up-down acceleration, a front-rear acceleration, and a right-left acceleration of a person. Changes of each acceleration is calculated in time, and used to determine walking ability of the subject.

[0012] In literature, several solutions according to prior art, for step-by-step navigation have been disclosed. In all these known solutions, combining simplicity, and thereby low cost, small size, low power consumption and accuracy, is a problem. The major error sources for the presented solutions are the coupling of gravitation to the measuring signal as the angle changes, unambiguous detection of the contact between foot and ground, and foot slipping at ground contact, whereby the acceleration signal and the speed signal are distorted.

Summary of the invention

[0013] The invention is defined by the scope of the attached claims.

[0014] The object of the invention is an improved method and device for measuring the progress of a moving person. By means of the method and device according to this invention, a precision is achieved equaling that of the best methods presented above, but with an implementation solution of significantly reduced complexity, using one acceleration sensor without any inclination compensation. The sensor solution according to the invention is applicable for use in a multitude of solutions for measuring different types of locomotion.

[0015] According to a first aspect of the invention, a method is provided for speed of a moving person. The method comprises measuring values of vertical acceleration of the body of the moving person during step cycles of the moving person by means of an acceleration sensor. The measured values of vertical acceleration are processed in an analysis unit based on a processor, the processing including filtering the measured values of vertical acceleration; defining for the step cycles a step cycle-specific characteristic maximum acceleration value a_{max} from the filtered values of vertical acceleration during a positive half-cycle; defining for the step cycles a step cycle-specific characteristic minimum acceleration value a_{min} from the filtered values of vertical acceleration during a negative half-cycle; and calculating speed of the moving person based on the step cycle-specific characteristic maximum acceleration value a_{max} or on the step cycle-specific characteristic minimum acceleration value a_{min}.

[0016] In an aspect, the method further includes digitally filtering the measured values of vertical acceleration, and the processing includes steps of defining for the step cycles a step cycle-specific characteristic maximum acceleration value a_{max} as a mean value of the digitally filtered values of vertical acceleration of the body measured during the positive half-cycle; and defining for the step cycles a step cycle-specific characteristic minimum acceleration value a_{min} as a mean value of the digitally filtered values of vertical acceleration of the body measured during the negative half-cycle.

[0017] In an aspect, the method further includes analogically filtering the measured values of vertical acceleration; defining for the step cycles the step cycle-specific characteristic maximum acceleration a_{max} as a maximum of the analogically filtered values of vertical acceleration of the body; and defining for the step cycles the step cycle-specific characteristic minimum accelerations a_{min} as a minimum of the analogically filtered values of vertical acceleration of the body.

[0018] In an aspect, the method further includes filtering the measured values of vertical acceleration with digital weighting; defining for the step cycles the step cycle-specific characteristic maximum acceleration a_{max} as a maximum of the filtered values of vertical acceleration of the body; and defining for the step cycles the step cycle-specific characteristic minimum accelerations a_{min} as a minimum of the filtered values of vertical acceleration of the body; wherein the function used in the digital weighting is:

$$a_{out}(n) = (1-k) * a_{out}(n-1) + a_{in} * k ,$$

where n indicates the nth sample value and k is a weighting factor.

[0019] In an aspect, the method further includes filtering the measured values of vertical acceleration with digital weighting, wherein the function used in the digital weighted filtering is:

$$a_{out}(n) = (1-k) * a_{out}(n-1) + a_{in} * k ,$$

where n indicates the nth sample and k is the weighting factor.

[0020] In an aspect, the method further includes calculating the speed v based on the characteristic maximum acceleration values a_{max} of the vertical acceleration as follows:

$$v \approx k \cdot \left(\frac{\frac{a_{\max}}{1g} + 1}{T_{step}} - f_{ref} \right),$$

where g is the acceleration caused by gravitation, f_{ref} is a reference frequency and the characteristic maximum acceleration a_{max} is the step cycle-specific characteristic maximum acceleration value filtered at a selected boundary frequency f_0.

[0021] In an aspect, the method further includes calculating the speed v based on the step cycle-specific characteristic minimum acceleration value a_{min} of the vertical acceleration as follows:

$$v \approx k \cdot \sqrt{|a_{\min}|} .$$

[0022] In an aspect, the method further includes deriving for the step cycles an acceleration graph from the measured values of vertical acceleration of the body; and calculating a time T_{step} used up for one step cycle as a time interval between equivalent points on two acceleration graphs, wherein the equivalent point is a maximum value in the acceleration graph, a minimum value in the acceleration graph, or a point where the value in the acceleration graph exceeds or falls below a certain value.

[0023] In an aspect, the method further includes calculating a step length s_{step} using the formula:

$$s_{step} = v * T_{step}.$$

[0024] In an aspect, the method further includes calculating a step rate f_{step} using the formula:

$$f_{step} = 1/T_{step}.$$

[0025] In an aspect, the method further includes detecting a number n of equivalent points on the acceleration graph; calculating a step count n on the basis of the detected number n of equivalent points.

[0026] In an aspect, the method further includes calculating a distance s covered by the moving person as the sum of the lengths of the steps:

$$s = \sum_{i=1}^{n} s_{step}(i).$$

[0027] In an aspect, the method further includes distinguishing ways of progress, like walking, running, and skiing, based on the characteristic maximum and minimum acceleration values a_{max} and a_{min} and/or the step rate.

[0028] In an aspect, the method further includes making an individual calibration for each way of progress.

[0029] In an aspect, the method further includes using the method in step-by-step navigation.

[0030] Also a device for measuring speed of a moving person is disclosed. The device comprises an acceleration sensor for measuring values of vertical acceleration of the body during step cycles of the moving person; means for filtering the measured values of vertical acceleration; means for defining for the step cycles a step cycle-specific characteristic maximum acceleration a_{max} from the filtered values of vertical acceleration within a positive half-cycle; and means for defining for the step cycles a characteristic minimum acceleration a_{min} from the filtered values of vertical acceleration within a negative half-cycle;

In an aspect, the device includes means for calculating speed of the moving person based on the step cycle-specific characteristic maximum acceleration value a_{max} or on the step cycle-specific characteristic minimum acceleration value a_{min}.

[0031] In an aspect, the device is further adapted to digitally filter the measured values of vertical acceleration; define for the step cycles a step cycle-specific characteristic maximum acceleration value a_{max} as a mean value of the digitally filtered values of vertical acceleration of the body measured during the positive half-cycle; and define for the step cycles a step cycle-specific characteristic minimum acceleration value a_{min} as a mean value of the digitally filtered values of vertical acceleration of the body measured during the negative half-cycle.

[0032] In an aspect, the device is further adapted to analogically filter the measured values of vertical acceleration; define for step cycles the step cycle-specific characteristic maximum acceleration a_{max} as a maximum of the analogically filtered values of vertical acceleration; and define for step cycles the step cycle-specific characteristic minimum accelerations a_{min} as a minimum of the analogically filtered values of vertical acceleration.

[0033] In an aspect, the device is adapted to filter the measured values of vertical acceleration with digital weighting; define for the step cycles the step cycle-specific characteristic maximum acceleration a_{max} as a maximum of the filtered values of vertical acceleration of the body; and define for step cycles the step cycle-specific characteristic minimum accelerations a_{min} as a minimum of the filtered values of vertical acceleration of the body, use in the digital weighted filtering a function:

$$a_{out}(n) = (1-k) * a_{out}(n-1) + a_{in} * k,$$

where n indicates the nth sample and k is a weighting factor.

[0034] In an aspect, the device is adapted to filter the measured values of vertical acceleration with digital weighting, and use in the digital weighted filtering a function:

$$a_{out}(n) = (1-k) * a_{out}(n-1) + a_{in} * k,$$

where n indicates the nth sample and k is a weighting factor.

[0035] In an aspect, the device is adapted to calculate the speed v based on the characteristic maximum acceleration values a_{max} of the vertical acceleration as follows:

$$v \approx k \cdot \left(\frac{\frac{a_{\max}}{1g} + 1}{T_{step}} - f_{ref} \right),$$

where g is the acceleration caused by gravitation, f_{ref} is a reference frequency and a_{max} is the step-cycle specific characteristic maximum acceleration filtered at a selected boundary frequency f_0.

[0036] In an aspect, the device is adapted to calculate the speed v based on the characteristic minimum acceleration values a_{min} of the vertical acceleration as follows:

$$v \approx k \cdot \sqrt{|a_{\min}|}.$$

[0037] In an aspect, the device is adapted to derive for the step cycles an acceleration graph from the measured values of vertical acceleration of the body; and calculate a time T_{step} used up for one step cycle as a time interval between equivalent points on two acceleration graphs, wherein the equivalent point is a maximum value in the acceleration graph, a minimum value in the acceleration graph, or a point where the value in the acceleration graph exceeds or falls below a certain value.

[0038] In an aspect, the device is adapted to calculate a step length s_{step} using a formula:

$$s_{step} = v * T_{step}.$$

[0039] In an aspect, the device is adapted to calculate a step rate f_{step} using a formula:

$$f_{step} = 1/T_{step}.$$

[0040] In an aspect, the device is adapted to detect a number n of equivalent points on the acceleration graph; and calculate a step count n on the basis of the detected number n of equivalent points.

[0041] In an aspect, the device is adapted to the device is adapted to calculate a distance s covered by the moving person as the sum of the step lengths:

$$s = \sum_{i=1}^{n} s_{step}(i).$$

[0042] In an aspect, the device is adapted to distinguish between ways of progress, like walking, running, and skiing, based on the characteristic maximum and minimum acceleration values a_{max} and a_{min} and/or the step rate.

[0043] In an aspect, the device is adapted to make an individual calibration for each way of progress, like running, walking, pole walking, or cross-country skiing.

[0044] In an aspect, the device is adapted for use in step-by-step navigation.

[0045] In an aspect, the device is adapted to cooperate with an altimeter, satellite navigation devices, and/or a magnetometer.

[0046] In an aspect, the device is adapted to receive and/or utilize map database data and/or terrain inclination data.

[0047] In an aspect, the device is adapted to adapted to be positioned at the middle of the body of a moving person.

[0048] In an aspect, the device is included in a piece of clothing, a piece of headwear, the neck, a pocket, or the belt of the moving person.

[0049] Also a system for measuring progress of a moving person is disclosed. The system comprises the device for measuring speed of a moving person and a display unit adapted to co-operate with the device.

[0050] In an aspect, said device for measuring speed of the moving person and said display unit for the moving person are integrated into one device.

Brief description of the drawings

[0051] Below, the invention and its preferred embodiments are described in detail with exemplary reference to the enclosed figures, of which:

Fig. 1 shows a diagram of a measuring apparatus according to the invention,

Fig. 2 shows a view of a measuring unit according to the invention, and

Fig. 3 shows a view of an alternative measuring unit according to the invention.

Detailed description of the invention

[0052] Fig. 1 shows a diagram of a measuring apparatus according to the invention. The apparatus can consist of a measuring unit 1, a storage unit 2 and a display unit 3. These communicate with each other using wireless or wired connections. Some of the units, or all of them, can be integrated in the same casing or unit. The measuring unit is attached close to the human body, e. g. close to the middle. The measuring unit is typically positioned at some garment of the moving person, like e.g. a piece of clothing, a piece of headwear, the neck, a pocket, or close to the middle, i.e. close to the body's center of gravity, e.g. at the belt. The display unit is typically located in a clearly visible position. It can be integrated, for example, in a measuring and storage unit, or it can be separate. It can also be part of a watch, a satellite navigator, a mobile terminal, a radio receiver, a player, or the like. Any calibration data for the measuring device are stored in one unit or in several units.

[0053] Fig. 2 shows a view of a measuring unit according to the invention. The measuring unit 1 can comprise an acceleration sensor 4 of 1 to 3 axes, a unit 5 for analysis and diagnostics of the acceleration data, a volatile and a nonvolatile memory 6, a communication unit 7, and a power supply 8, e.g. a battery, an accumulator, a harvester or some similar device. The analysis unit can, for example, be based on a microprocessor or a DSP (Digital

Signal Processor). The memory stores, for instance, user data, calibration data, measurement data and other log data. The communication unit comprises, for example, a transfer protocol generator, a required interface, or a radio transmitter, a receiver and an antenna.

[0054] The measuring unit can be positioned fastened close to the human body, like, for example, close to the middle, i.e. close to the body's center of gravity. The measuring unit is, typically, positioned at the clothing of the moving person, like, for instance, a piece of clothing, a piece of headwear, the neck, a pocket, or the belt.

[0055] Fig. 3 shows a view of an alternative measuring unit according to the invention. If, in addition to the speed and the distance covered, one wants to know the traveled route, a magnetometer 11 of 2 or 3 axes can be added to the alternative measuring unit for the compass direction to be determined for each step, or once in a while.

[0056] In the solution according to the invention, the acceleration of the cyclic motion of progress is being measured in one or more directions. From the vertical acceleration values measured during each step cycle, a characteristic maximum acceleration a_{max} occurring during the positive half cycle or the acceleration stage and, respectively, a characteristic minimum acceleration a_{min} occurring during the negative half cycle or the braking stage are being determined.

[0057] As values of the characteristic maximum acceleration a_{max} and the characteristic minimum acceleration a_{min} accelerations are defined, that clearly differ from zero, whereby the influence of the zero point error in the acceleration sensor or of the coupling of gravitation, caused by inclination, on the metering signal is minimal, since they are clearly lower than the values a_{max} and a_{min}.

[0058] In the solution according to the invention, the characteristic maximum acceleration a_{max} and the characteristic minimum acceleration a_{min} can be defined, for example, directly as the maximum and/or the minimum of the vertical acceleration value from the raw data measured by the acceleration sensor. Alternatively, in the solution according to the invention, the values a_{max} and a_{min} can be defined by filtering the acceleration sensor signal a_{in} analogically by, for example, mechanical damping of the signal a_{in}.

[0059] Further, alternatively, in a solution according to the invention, the values a_{max} and a_{min} can be defined by filtering the acceleration sensor signal a_{in} digitally, by means of, for example, an RC filter. In this case, in the digital filtering, the function used in the first stage filtering could be, for instance:

$$a_{out} = a_{in} / \sqrt{\left[1 + (f / f_0)^2\right]},$$

where f = frequency and f_0 = the boundary frequency for -3dB and the values a_{max} and a_{min} can be defined based on this filtered signal as, for example, the maximum and/or the minimum of the filtered acceleration value.

[0060] Further, alternatively, in the solution according to the invention, the values a_{max} and a_{min} can be defined by filtering the acceleration sensor signal a_{in} by means of digital weighting. Here, the function to be used in the digital weighting could be, for instance:

$$a_{out}(n) = (1-k) * a_{out}(n-1) + a_{in} * k,$$

where n indicates the n th sample and k is the weighting factor.

[0061] Further, alternatively, in a solution according to the invention, the values a_{max} and a_{min} can be defined by using a mean value calculated from the measured acceleration value over times selected during the positive and/or the negative half cycle.

[0062] The time used up for one step T_{step} is obtained as the time interval between two equivalent points, such a maximum, a minimum, or a point of exceeding or falling below a certain value, on the acceleration graph given by the measured values of vertical acceleration. The time T_C spent in ground contact during a step is obtained based on the length of time of zero acceleration in the acceleration graph derived from the measured vertical acceleration values.

[0063] For running, it has been noted that the speed is proportional to the inverse of the contact time and to the force produced in the take off. Since the average vertical acceleration of the body is zero,

$$T_C \cdot a_{\max} + (T_{step} - T_C) \cdot a_{\min} = 0,$$

the speed of locomotion v is obtained based on the characteristic maximum acceleration a_{max}, in other words,

$$v \approx k \cdot \left(\frac{\frac{a_{\max}}{1g} + 1}{T_{step}} - f_{ref} \right),$$

where g is the acceleration caused by gravitation, f_{ref} is a reference frequency and the characteristic maximum acceleration a_{max} is the maximum value of the vertical acceleration strongly filtered at, for instance, the boundary frequency f_0 = 6 Hz. In running, the characteristic maximum acceleration a_{max} of the middle or some other part of the body is a good measure of the speed of progress.

[0064] For walking, the speed is obtained based on the characteristic minimum acceleration a_{min} of the vertical acceleration, in other words,

$$v \approx k \cdot \sqrt{|a_{\min}|}.$$

[0065] The factors k depend, to some extent, on the boundary frequency in the filtering of the acceleration data. In walking, the characteristic minimum acceleration a_{min} of the middle or some other part of the body is a good measure of the speed of progress.

[0066] In the solution according to the invention, the step length s_{step} can be calculated using the formula:

$$s_{step} = v * T_{step},$$

and, correspondingly, the step rate or the cadence f_{step} can be calculated using the formula:

$$f_{step} = 1/T_{step}.$$

[0067] In the solution according to the invention, running and walking can be distinguished from each other based on step rate and speed of progress. At low running speeds, a non-linear model can be used, and running and walking can be adapted to each other.

[0068] In the solution according to the invention, the step count n can be calculated on the basis of the number n of equivalent points, such a maximum, a minimum, or a point of exceeding or falling below a certain value, on the acceleration graph given by the measured values of vertical acceleration. Further, in the solution according to the invention, the distance covered s can be calculated as the sum of the step lengths:

$$s = \sum_{i=1}^{n} s_{step}(i).$$

[0069] In the solution according to the invention, a single acceleration sensor of one axis can be used, and thus, implementing the calculations of the formulae presented above is a simple task by means of, for example, a microcontroller. This enables a small, low cost, and low power sensor solution, by means of which a precision sufficient for consumer products is achieved. Without individual calibration, the relative error, at distances exceeding one kilometer, is less than 10%.

[0070] In the solution according to the invention, an acceleration sensor of many axes can be used as well, and that enables, for example, diagnosing stationary running.

[0071] In the solution according to the invention, a magnetometer of two axes can also be used, by means of which the length and direction of every step can be obtained. There will be inclination compensation as well, since the inclination of the body is more or less constant. Calibration of direction and speed can be done by running a straight line back and forth.

[0072] In the solution according to the invention, the speed estimate suffers a minimal impact from the zero point error in the acceleration sensor or from gravitation coupling into the metering signal caused by inclination, when using the characteristic maximum acceleration a_{max} and the characteristic minimum acceleration a_{min}, which values are large numbers in comparison with those. The ways of progress, e.g. walking, running, and skiing, can be distinguished from each other based on the characteristic maximum acceleration a_{max}, the characteristic minimum acceleration a_{min}, and/or the step rate.

[0073] In the solution according to the invention, based on the acceleration values measured during the step cycles, characteristic maximum acceleration and characteristic minimum acceleration values a_{max} and a_{min} for each step cycle are defined, by means of which values the speed, the step rate, the step length, and the distance can be calculated with low power consumption using simple arithmetic, for example by using a polynome.

[0074] The system, even if not calibrated, provides good precision. In order to improve precision, individual calibration can be made for different modes of progress, e.g. running, walking, pole walking, or cross-country skiing. This can be done over a known distance using one speed or a multitude of speeds. By repeating the calibration, errors in speed and distance caused by stochastic errors are reduced, whereby precision is further improved. New calibration data can be added to the old data by suitable digital filtering. In addition, for further improvement of the precision, information about the characteristic maximum and minimum acceleration values a_{max} and a_{min} can be combined with contact time data, with change in altitude and terrain inclination data obtained from an altimeter, and/or with satellite navigation.

[0075] A complete step-by-step navigation unit is provided by adding to the step data the compass direction obtained from a magnetometer. The magnetometer can be calibrated, e.g. by rotating about a vertical axis. A direction error in the installation can be calibrated away by, e.g. walking a selected calibration route back and forth. Absolute coordinate data is obtained by combining this navigation unit with satellite navigation. Precision is further improved by combining the navigation unit with a map database and with an altimeter, since plausibility checks of the coordinates and movement can be made based on the altitude and changes in altitude.

[0076] By using an acceleration sensor signal perpendicular to the principal metering direction, a measure of the efficiency of locomotion is obtained.

[0077] In the solution according to the invention, characteristic maximum acceleration and characteristic minimum acceleration values a_{max} and a_{min} and/or maximum and/or minimum acceleration values obtained from an acceleration sensor of one or more axes can be used for estimating the speed of progress of a person. The signal of the acceleration sensor can be suitably filtered by means of mechanical, electronic, analog and/or digital filtering such, that the speed estimate is as exact and reliable as possible. In the solution according to the invention, step time, step rate, step length, and distance accumulated from the steps can be calculated based on the speed and the time interval between consecutive maxima or minima.

[0078] In the solution according to the invention, walking, running, and skiing, or some other way of progress can be distinguished from each other based on, for example, the maximum and minimum acceleration of the middle of the body, the characteristic maximum and minimum acceleration values a_{max} and a_{min} and/or the step rate.

[0079] In the solution according to the invention, the parameters for an average person running and walking can be utilized without individual calibration of the measuring system. The measuring system can be calibrated by means of individual calibration for one speed or for a multitude of speeds for a certain way of progress, e.g. running or walking. In the solution according to the invention, the calibration of the measuring system can be repeated such, that new data is combined with the old data by digital filtering. The precision of the measuring system can be improved by combining contact time data with the maximum and minimum acceleration data.

[0080] In the solution according to the invention, the direction of each step or the direction of the distance covered observed from time to time can be determined by combining the speed estimate with the compass direction obtained from a magnetometer of 2 or 3 axes. A magnetometer and an installation direction error can be compensated for by rotating about a vertical axis and by walking a selected calibration route back and forth.

[0081] In the solution according to the invention, the efficiency of the locomotion can be estimated by combining with the characteristic maximum acceleration values and the characteristic minimum acceleration values a_{max} and a_{min} and/or with the maximum and minimum acceleration value data, acceleration values measured at right angles to those.

[0082] By means of the method and device according to the invention, a precision is achieved equal to that of the best methods presented above, by an implementation solution of significantly greater simplicity, utilizing one acceleration sensor without inclination compensation.

[0083] By means of the method and device according to the invention, the complicated algorithms of prior systems are avoided, and low cost, low power consumption, and small size are achieved.

[0084] The low power consumption of the method and device according to the invention allows a small battery and gives it long life, or even a battery-free solution based on, for example, recovery of the kinetic energy occurring in the measuring device (harvesting).

[0085] The simple measuring algorithm of the method and device according to the invention allows the computations to be performed entirely in the measuring unit, which reduces the need for data transfer from the measuring unit, and thus, the power consumption of data transmission utilizing radio traffic.

[0086] The small size of the measuring unit of the solution according to the invention allows the unit to be positioned, for example, at a piece of garment of the moving person, like, for example a piece of clothing, a piece of headwear, the neck, a pocket or close to the middle of the body, i.e. near the center of gravity of the body, at the belt, for instance. The method according to the invention is applicable, for example, to both slow and fast running, to walking at various speeds, pole walking cross-country skiing, downhill sports, roller skiing, roller-skating and skating.

[0087] The method and device according to the invention can be used for measuring a moving person's speed, the step length, and the distance covered, based on maximum and minimum acceleration values of the body, given by an acceleration sensor of one axis for vertical acceleration and/or characteristic maximum and minimum acceleration values a_{max} and a_{min}. In the solution according to the invention, the acceleration signal can be optimally filtered such, that the acceleration signal gives as good a picture of the speed as possible.

[0088] In the solution according to the invention, the ways of locomotion of the moving person, like walking and running, can be distinguished from each other based on the cadence and the speed of locomotion. In the solution according to the invention the parameters for an average person walking and running can be utilized without any individual calibration of the measuring system. The solution according to the invention enables calibration of the single point measuring system for walking and for running.

[0089] The solution according to the invention enables diagnosing stationary running by means of a sensor of longitudinal acceleration. The solution according to the invention enables the direction of each step and the distance covered to be determined by means of a compass of two or three axes. The solution according to the invention enables calibration of the installation error of the compass by traveling the same route back and forth.

Claims

1. A method for measuring speed of a moving person, the method comprising:

    measuring values of vertical acceleration of the body of the moving person during step cycles of the moving person by means of an acceleration sensor (4);
    processing the measured values of vertical acceleration in an analysis unit (5) based on a processor, the processing including:

        filtering the measured values of vertical acceleration; **characterized by** further defining for the step cycles a step cycle-spe-

cific characteristic maximum acceleration value a_{max} from the filtered values of vertical acceleration during a positive half-cycle;
defining for the step cycles a step cycle-specific characteristic minimum acceleration value a_{min} from the filtered values of vertical acceleration during a negative half-cycle;
calculating speed of the moving person based on the step cycle-specific characteristic maximum acceleration value a_{max} or on the step cycle-specific characteristic minimum acceleration value a_{min}.

2. Method according to claim 1, **characterized by:**

digitally filtering the measured values of vertical acceleration;
defining for the step cycles a step cycle-specific characteristic maximum acceleration value a_{max} as a mean value of the digitally filtered values of vertical acceleration of the body measured during the positive half-cycle;
defining for the step cycles a step cycle-specific characteristic minimum acceleration value a_{min} as a mean value of the digitally filtered values of vertical acceleration of the body measured during the negative half-cycle.

3. Method according to claim 1, **characterized by:**

analogically filtering the measured values of vertical acceleration;
defining for the step cycles the step cycle-specific characteristic maximum acceleration a_{max} as a maximum of the analogically filtered values of vertical acceleration of the body;
defining for the step cycles the step cycle-specific characteristic minimum accelerations a_{min} as a minimum of the analogically filtered values of vertical acceleration of the body.

4. Method according to claim 1, **characterized by** filtering the measured values of vertical acceleration with digital weighting;
defining for the step cycles the step cycle-specific characteristic maximum acceleration a_{max} as a maximum of the filtered values of vertical acceleration of the body;
defining for the step cycles the step cycle-specific characteristic minimum accelerations a_{min} as a minimum of the filtered values of vertical acceleration of the body;
wherein the function used in the digital weighting is:

$$a_{out}(n) = (1-k) * a_{out}(n-1) + a_{in} * k ,$$

where n indicates the nth sample value and k is a weighting factor.

5. Method according to claim 2, **characterized by:** filtering the measured values of vertical acceleration with digital weighting, wherein the function used in the digital weighted filtering is:

$$a_{out}(n) = (1-k) * a_{out}(n-1) + a_{in} * k ,$$

where n indicates the nth sample and k is the weighting factor.

6. Method according to any one of the preceding claims 1 to 5, **characterized by** the calculating the speed v based on the characteristic maximum acceleration values a_{max} of the vertical acceleration as follows:

$$v \approx k \cdot \left(\frac{\frac{a_{\max}}{1g} + 1}{T_{step}} - f_{ref} \right),$$

where g is the acceleration caused by gravitation, f_{ref} is a reference frequency and the characteristic maximum acceleration a_{max} is the step cycle-specific characteristic maximum acceleration value filtered at a selected boundary frequency f_0.

7. Method according to any one of the preceding claims 1 to 5, **characterized by** calculating the speed v based on the step cycle-specific characteristic minimum acceleration value a_{min} of the vertical acceleration as follows:

$$v \approx k \cdot \sqrt{|a_{\min}|} .$$

8. Method according to any one of the claims 1 to 8, **characterized by:**

deriving for the step cycles an acceleration graph from the measured values of vertical acceleration of the body;
calculating a time T_{step} used up for one step cycle as a time interval between equivalent points on two acceleration graphs, wherein the equivalent point is a maximum value in the acceleration graph, a minimum value in the acceleration graph, or a point where the value in the acceleration graph exceeds or falls below a certain value.

9. Method according to claim 8, **characterized by** calculating a step length s_{step} using the formula:

$$s_{step} = v * T_{step} .$$

10. Method according to claim 8 or 9, **characterized by** calculating a step rate f_{step} using the formula:

$$f_{step} = 1 / T_{step} .$$

11. Method according to claim 8, 9, or 10, **characterized by:**

detecting a number n of equivalent points on the acceleration graph;
calculating a step count n on the basis of the detected number n of equivalent points.

12. Method according to claim 11, **characterized by** calculating a distance s covered by the moving person as the sum of the lengths of the steps:

$$s = \sum_{i=1}^{n} s_{step}(i) .$$

13. Method according to any one of the preceding claims 1 to 12, **characterized by** distinguishing ways of progress, like walking, running, and skiing, based on the characteristic maximum and minimum acceleration values a_{max} and a_{min} and/or the step rate.

14. Method according to claim 13, **characterized by** making an individual calibration for each way of progress.

15. Method according to any one of the preceding claims 1 to 14, **characterized by** using the method in step-by-step navigation.

16. A device for measuring speed of a moving person, **characterized in that** the device comprises:

an acceleration sensor (4) for measuring values of vertical acceleration of the body during step cycles of the moving person;
means (5) for filtering the measured values of vertical acceleration;
means (5) for defining for the step cycles a step cycle-specific characteristic maximum acceleration a_{max} from the filtered values of vertical acceleration within a positive half-cycle;
means (5) for defining for the step cycles a characteristic minimum acceleration a_{min} from the filtered values of vertical acceleration within a negative half-cycle;
means (5) for calculating speed of the moving person based on the step cycle-specific characteristic maximum acceleration value a_{max} or on the step cycle-specific characteristic minimum acceleration value a_{min}.

17. Device according to claim 16, **characterized in that** the device is further adapted to:

digitally filter the measured values of vertical acceleration;
define for the step cycles a step cycle-specific characteristic maximum acceleration value a_{max} as a mean value of the digitally filtered values of vertical acceleration of the body measured during the positive half-cycle;
define for the step cycles a step cycle-specific characteristic minimum acceleration value a_{min} as a mean value of the digitally filtered values of vertical acceleration of the body measured during the negative half-cycle.

18. Device according to claim 16, **characterized in that** the device is further adapted to:

analogically filter the measured values of vertical acceleration;
define for step cycles the step cycle-specific characteristic maximum acceleration a_{max} as a maximum of the analogically filtered values of vertical acceleration;
define for step cycles the step cycle-specific characteristic minimum accelerations a_{min} as a minimum of the analogically filtered values of vertical acceleration.

19. Device according to claim 16, **characterized in that** the device is adapted to:

filter the measured values of vertical acceleration with digital weighting;
define for the step cycles the step cycle-specific characteristic maximum acceleration a_{max} as a maximum of the filtered values of vertical acceleration of the body;
define for step cycles the step cycle-specific characteristic minimum accelerations a_{min} as a minimum of the filtered values of vertical acceleration of the body,
use in the digital weighted filtering a function:

$$a_{out}(n) = (1-k) * a_{out}(n-1) + a_{in} * k ,$$

where n indicates the nth sample and k is a weighting factor.

20. Device according to claim 16, **characterized in that** the device is adapted to filter the measured values of vertical acceleration with digital weighting, and use in the digital weighted filtering a function:

$$a_{out}(n) = (1-k) * a_{out}(n-1) + a_{in} * k \text{ ,}$$

where *n* indicates the *n*th sample and *k* is a weighting factor.

21. Device according to any one of the preceding claims 16 to 20, **characterized in that** the device is adapted to calculate the speed *v* based on the characteristic maximum acceleration values $a_{\max}$ of the vertical acceleration as follows:

$$v \approx k \cdot \left(\frac{\frac{a_{\max}}{1g} + 1}{T_{step}} - f_{ref} \right),$$

where *g* is the acceleration caused by gravitation, f_{ref} is a reference frequency and $a_{\max}$ is the step-cycle specific characteristic maximum acceleration filtered at a selected boundary frequency f_0.

22. Device according to any one of the preceding claims 16 to 20, **characterized in that** the device is adapted to calculate the speed *v* based on the characteristic minimum acceleration values $a_{\min}$ of the vertical acceleration as follows:

$$v \approx k \cdot \sqrt{|a_{\min}|} \text{ .}$$

23. Device according to any one of the preceding claims 16 to 22, **characterized in that** the device is adapted to:

derive for the step cycles an acceleration graph from the measured values of vertical acceleration of the body;
calculate a time T_{step} used up for one step cycle as a time interval between equivalent points on two acceleration graphs, wherein the equivalent point is a maximum value in the acceleration graph, a minimum value in the acceleration graph, or a point where the value in the acceleration graph exceeds or falls below a certain value.

24. Device according to claim 23, **characterized in that** the device is adapted to calculate a step length s_{step} using a formula:

$$s_{step} = v * T_{step} \text{ .}$$

25. Device according to claim 23 or 24, **characterized in that** the device is adapted to calculate a step rate f_{step} using a formula:

$$f_{step} = 1 / T_{step} \text{ .}$$

26. Device according to claim 23, 24, or 25, **characterized in that** the device is adapted to:

detect a number *n* of equivalent points on the acceleration graph;
calculate a step count *n* on the basis of the detected number *n* of equivalent points.

27. Device according to any one of the preceding claims 24 to 26, **characterized in that** the device is adapted to calculate a distance *s* covered by the moving person as the sum of the step lengths:

$$s = \sum_{i=1}^{n} s_{step}(i) \text{ .}$$

28. Device according to any one of the preceding claims 16 to 25, **characterized in that** the device is adapted to distinguish between ways of progress, like walking, running, and skiing, based on the characteristic maximum and minimum acceleration values $a_{\max}$ and $a_{\min}$ and/or the step rate.

29. Device according to claim 28, **characterized in that** the device is adapted to make an individual calibration for each way of progress, like running, walking, pole walking, or cross-country skiing.

30. Device according to any one of the preceding claims 16 to 29, **characterized in that** the device is adapted for use in step-by-step navigation.

31. Device according to claim 30, **characterized in that** the device is adapted to cooperate with an altimeter, satellite navigation devices, and/or a magnetometer.

32. Device according to claim 30 or 31, **characterized in that** the device is adapted to receive and/or utilize map database data and/or terrain inclination data.

33. Device according to any one of the preceding claims 16 to 32 adapted to be positioned at the middle of the body of a moving person .

34. Device according to claim 31, **characterized in that** the device is included in a piece of clothing, a piece of headwear, the neck, a pocket, or the belt of the moving person.

35. System for measuring progress of a moving person, **characterized in that** the system comprises a device according to any one of the preceding claims 16 to 34, and a display unit adapted to co-operate with the device.

36. System according to claim 35, **characterized in that** said device for measuring speed of the moving person and said display unit for the moving person are integrated into one device.

Patentansprüche

1. Verfahren zum Messen der Geschwindigkeit einer sich bewegenden Person, wobei das Verfahren umfasst:

Messen von Werten der Vertikalbeschleunigung des Körpers der sich bewegenden Person während Schrittzyklen der sich bewegenden Person mittels eines Beschleunigungssensors (4);
Verarbeiten der Messwerte der Vertikalbeschleunigung in einer Analyseeinheit (5) basierend auf einem Prozessor, wobei das Verarbeiten umfasst:

Filtern der Messwerte der Vertikalbeschleunigung; ferner **gekennzeichnet durch**
Festlegen eines schrittzyklusspezifischen charakteristischen maximalen Beschleunigungswertes a_{max} für die Schrittzyklen aus den gefilterten Werten der Vertikalbeschleunigung während eines positiven Halbzyklus;
Festlegen eines schrittzyklusspezifischen charakteristischen minimalen Beschleunigungswertes a_{min} für die Schrittzyklen aus den gefilterten Werten der Vertikalbeschleunigung während eines negativen Halbzyklus;
Berechnen der Geschwindigkeit der sich bewegenden Person basierend auf dem schrittzyklusspezifischen charakteristischen maximalen Beschleunigungswert a_{max} oder dem schrittzyklusspezifischen charakteristischen minimalen Beschleunigungswert a_{min}.

2. Verfahren nach Anspruch 1, **gekennzeichnet durch:**

digitales Filtern der Messwerte der Vertikalbeschleunigung;
Festlegen eines schrittzyklusspezifischen charakteristischen maximalen Beschleunigungswertes a_{max} für die Schrittzyklen als Mittelwert der während des positiven Halbzyklus gemessenen, digital gefilterten Werte der Vertikalbeschleunigung des Körpers;
Festlegen eines schrittzyklusspezifischen charakteristischen minimalen Beschleunigungswertes a_{min} für die Schrittzyklen als Mittelwert der während des negativen Halbzyklus gemessenen, digital gefilterten Werte der Vertikalbeschleunigung des Körpers.

3. Verfahren nach Anspruch 1, **gekennzeichnet durch:**

analoges Filtern der Messwerte der Vertikalbeschleunigung;
Festlegen der schrittzyklusspezifischen charakteristischen maximalen Beschleunigung a_{max} für die Schrittzyklen als Maximum der analog gefilterten Werte der Vertikalbeschleunigung des Körpers;
Festlegen der schrittzyklusspezifischen charakteristischen minimalen Beschleunigungen a_{min} für die Schrittzyklen als Minimum der analog gefilterten Werte der Vertikalbeschleunigung des Körpers.

4. Verfahren nach Anspruch 1, **gekennzeichnet durch**
Filtern der Messwerte der Vertikalbeschleunigung mit digitaler Gewichtung;
Festlegen der schrittzyklusspezifischen charakteristischen maximalen Beschleunigung a_{max} für die Schrittzyklen als Maximum der gefilterten Werte der Vertikalbeschleunigung des Körpers;
Festlegen der schrittzyklusspezifischen charakteristischen minimalen Beschleunigungen a_{min} für die Schrittzyklen als Minimum der gefilterten Werte der Vertikalbeschleunigung des Körpers;
wobei die bei der digitalen Gewichtung verwendete Funktion lautet:

$$a_{out}(n) = (1-k) * a_{out}(n-1) + a_{in} * k,$$

wobei gilt: *n* zeigt den *n*-ten Abtastwert an und *k* ist ein Gewichtungsfaktor.

5. Verfahren nach Anspruch 2, **gekennzeichnet durch:**
Filtern der Messwerte der Vertikalbeschleunigung mit digitaler Gewichtung, wobei die bei der digital gewichteten Filterung verwendete Funktion lautet:

$$a_{out}(n) = (1-k) * a_{out}(n-1) + a_{in} * k,$$

wobei gilt: *n* zeigt die *n*-te Abtastung an und *k* ist der Gewichtungsfaktor.

6. Verfahren nach einem der vorhergehenden Ansprüche 1 bis 5, **gekennzeichnet durch** das Berechnen der Geschwindigkeit v basierend auf den charakteristischen maximalen Beschleunigungswerten a_{max} der Vertikalbeschleunigung wie folgt:

$$v \approx k \cdot \left(\frac{\frac{a_{max}}{1g} + 1}{T_{step}} - f_{ref} \right),$$

wobei gilt: g ist die durch die Gravitation verursachte Beschleunigung, f_{ref} ist eine Referenzfrequenz, und die charakteristische maximale Beschleunigung a_{max} ist der bei einer ausgewählten Grenzfrequenz f_0 gefilterte schrittzyklusspezifische charakteristische maximale Beschleunigungswert.

7. Verfahren nach einem der vorhergehenden Ansprüche 1 bis 5, **gekennzeichnet durch** das Berechnen der Geschwindigkeit v basierend auf dem schrittzyklusspezifischen charakteristischen minimalen Beschleunigungswert a_{min} der Vertikalbeschleunigung wie folgt:

$$v \approx k \cdot \sqrt{|a_{min}|}.$$

8. Verfahren nach einem der Ansprüche 1 bis 8, **gekennzeichnet durch**:

Herleiten eines Beschleunigungsgraphen für die Schrittzyklen aus den Messwerten der Vertikalbeschleunigung des Körpers;
Berechnen einer für einen Schrittzyklus aufgewendeten Zeit T_{step} als Zeitintervall zwischen äquivalenten Punkten auf zwei Beschleunigungsgraphen, wobei der äquivalente Punkt ein Maximalwert im Beschleunigungsgraphen, ein Minimalwert im Beschleunigungsgraphen oder ein Punkt ist, an dem der Wert im Beschleunigungsgraphen einen bestimmten Wert überschreitet oder unterschreitet.

9. Verfahren nach Anspruch 8, **gekennzeichnet durch** Berechnen einer Schrittlänge s_{step} mit Hilfe der Formel:

$$s_{step} = v * T_{step}.$$

10. Verfahren nach Anspruch 8 oder 9, **gekennzeichnet durch** Berechnen einer Schrittfrequenz f_{step} mit Hilfe der Formel:

$$f_{step} = 1 / T_{step}.$$

11. Verfahren nach Anspruch 8, 9 oder 10, **gekennzeichnet durch**:

Erfassen einer Anzahl *n* von äquivalenten Punkten auf dem Beschleunigungsgraphen;
Berechnen einer Schrittzahl *n* basierend auf der erfassten Anzahl *n* von äquivalenten Punkten.

12. Verfahren nach Anspruch 11, **gekennzeichnet durch** Berechnen einer von der sich bewegenden Person zurückgelegten Strecke *s* als Summe der Längen der Schritte:

$$s = \sum_{i=1}^{n} s_{step}(i).$$

13. Verfahren nach einem der vorhergehenden Ansprüche 1 bis 12, **gekennzeichnet durch** Unterscheiden von Arten der Fortbewegung wie Gehen, Laufen und Skifahren basierend auf den charakteristischen maximalen und minimalen Beschleunigungswerten a_{max} und a_{min} und/oder der Schrittfrequenz.

14. Verfahren nach Anspruch 13, **gekennzeichnet durch** Ausführen einer individuellen Kalibrierung für jede Art der Fortbewegung.

15. Verfahren nach einem der vorhergehenden Ansprüche 1 bis 14, **gekennzeichnet durch** Verwenden des Verfahrens in der Schritt-für-Schritt-Navigation.

16. Vorrichtung zum Messen der Geschwindigkeit einer sich bewegenden Person, **dadurch gekennzeichnet, dass** die Vorrichtung umfasst:

einen Beschleunigungssensor (4) zum Messen von Werten der Vertikalbeschleunigung des Körpers während Schrittzyklen der sich bewegenden Person;
Mittel (5) zum Filtern der Messwerte der Vertikalbeschleunigung;
Mittel (5) zum Festlegen einer schrittzyklusspezifischen charakteristischen maximalen Beschleunigung a_{max} für die Schrittzyklen aus den gefilterten Werten der Vertikalbeschleunigung innerhalb eines positiven Halbzyklus;

Mittel (5) zum Festlegen einer charakteristischen minimalen Beschleunigung a_{min} für die Schrittzyklen aus den gefilterten Werten der Vertikalbeschleunigung innerhalb eines negativen Halbzyklus;
Mittel (5) zum Berechnen der Geschwindigkeit der sich bewegenden Person basierend auf dem schrittzyklusspezifischen charakteristischen maximalen Beschleunigungswert a_{max} oder dem schrittzyklusspezifischen charakteristischen minimalen Beschleunigungswert a_{min}.

17. Vorrichtung nach Anspruch 16, **dadurch gekennzeichnet, dass** die Vorrichtung ferner eingerichtet ist zum:

digitalen Filtern der Messwerte der Vertikalbeschleunigung;
Festlegen eines schrittzyklusspezifischen charakteristischen maximalen Beschleunigungswertes a_{max} für die Schrittzyklen als Mittelwert der während des positiven Halbzyklus gemessenen, digital gefilterten Werte der Vertikalbeschleunigung des Körpers;
Festlegen eines schrittzyklusspezifischen charakteristischen minimalen Beschleunigungswertes a_{min} für die Schrittzyklen als Mittelwert der während des negativen Halbzyklus gemessenen, digital gefilterten Werte der Vertikalbeschleunigung des Körpers.

18. Vorrichtung nach Anspruch 16, **dadurch gekennzeichnet, dass** die Vorrichtung ferner eingerichtet ist zum:

analogen Filtern der Messwerte der Vertikalbeschleunigung;
Festlegen der schrittzyklusspezifischen charakteristischen maximalen Beschleunigung a_{max} für die Schrittzyklen als Maximum der analog gefilterten Werte der Vertikalbeschleunigung;
Festlegen der schrittzyklusspezifischen charakteristischen minimalen Beschleunigungen a_{min} für die Schrittzyklen als Minimum der analog gefilterten Werte der Vertikalbeschleunigung.

19. Vorrichtung nach Anspruch 16, **dadurch gekennzeichnet, dass** die Vorrichtung eingerichtet ist zum:

Filtern der Messwerte der Vertikalbeschleunigung mit digitaler Gewichtung;
Festlegen der schrittzyklusspezifischen charakteristischen maximalen Beschleunigung a_{max} für die Schrittzyklen als Maximum der gefilterten Werte der Vertikalbeschleunigung des Körpers;
Festlegen der schrittzyklusspezifischen charakteristischen minimalen Beschleunigungen a_{min} für die Schrittzyklen als Minimum der gefilterten Werte der Vertikalbeschleunigung des Körpers, beim digital gewichteten Filtern Verwenden einer Funktion:

$$a_{out}(n) = (1-k) * a_{out}(n-1) + a_{in} * k \,,$$

wobei gilt: n zeigt die n-te Abtastung an und k ist ein Gewichtungsfaktor.

20. Vorrichtung nach Anspruch 16, **dadurch gekennzeichnet, dass** die Vorrichtung eingerichtet ist zum Filtern der Messwerte der Vertikalbeschleunigung mit digitaler Gewichtung und, beim digital gewichteten Filtern, Verwenden einer Funktion:

$$a_{out}(n) = (1-k) * a_{out}(n-1) + a_{in} * k \,,$$

wobei gilt: n zeigt die n-te Abtastung an und k ist ein Gewichtungsfaktor.

21. Vorrichtung nach einem der vorhergehenden Ansprüche 16 bis 20, **dadurch gekennzeichnet, dass** die Vorrichtung eingerichtet ist zum Berechnen der Geschwindigkeit v basierend auf den charakteristischen maximalen Beschleunigungswerten a_{max} der Vertikalbeschleunigung wie folgt:

$$v \approx k \cdot \left(\frac{\frac{a_{max}}{1g} + 1}{T_{step}} - f_{ref} \right),$$

wobei gilt: g ist die durch die Gravitation verursachte Beschleunigung, f_{ref} ist eine Referenzfrequenz, und a_{max} ist die bei einer ausgewählten Grenzfrequenz f_0 gefilterte schrittzyklusspezifische charakteristische maximale Beschleunigung.

22. Vorrichtung nach einem der vorhergehenden Ansprüche 16 bis 20, **dadurch gekennzeichnet, dass** die Vorrichtung eingerichtet ist zum Berechnen der Geschwindigkeit v basierend auf den charakteristischen minimalen Beschleunigungswerten a_{min} der Vertikalbeschleunigung wie folgt:

$$v \approx k \cdot \sqrt{|a_{min}|}\,.$$

23. Vorrichtung nach einem der vorhergehenden Ansprüche 16 bis 22, **dadurch gekennzeichnet, dass** die Vorrichtung eingerichtet ist zum:

Herleiten eines Beschleunigungsgraphen für

die Schrittzyklen aus den Messwerten der Vertikalbeschleunigung des Körpers;
Berechnen einer für einen Schrittzyklus aufgewendeten Zeit T_{step} als Zeitintervall zwischen äquivalenten Punkten auf zwei Beschleunigungsgraphen, wobei der äquivalente Punkt ein Maximalwert im Beschleunigungsgraphen, ein Minimalwert im Beschleunigungsgraphen oder ein Punkt ist, an dem der Wert im Beschleunigungsgraphen einen bestimmten Wert überschreitet oder unterschreitet.

24. Vorrichtung nach Anspruch 23, **dadurch gekennzeichnet, dass** die Vorrichtung eingerichtet ist zum Berechnen einer Schrittlänge s_{step} mit Hilfe einer Formel:

$$s_{step} = v * T_{step} .$$

25. Vorrichtung nach Anspruch 23 oder 24, **dadurch gekennzeichnet, dass** die Vorrichtung eingerichtet ist zum Berechnen einer Schrittfrequenz f_{step} mit Hilfe einer Formel:

$$f_{step} = 1 / T_{step} .$$

26. Vorrichtung nach Anspruch 23, 24 oder 25, **dadurch gekennzeichnet, dass** die Vorrichtung eingerichtet ist zum:

Erfassen einer Anzahl n von äquivalenten Punkten auf dem Beschleunigungsgraphen;
Berechnen einer Schrittzahl n basierend auf der erfassten Anzahl n von äquivalenten Punkten.

27. Vorrichtung nach einem der vorhergehenden Ansprüche 24 bis 26, **dadurch gekennzeichnet, dass** die Vorrichtung eingerichtet ist zum Berechnen einer von der sich bewegenden Person zurückgelegten Strecke s als Summe der Schrittlängen:

$$s = \sum_{i=1}^{n} s_{step}(i) .$$

28. Vorrichtung nach einem der vorhergehenden Ansprüche 16 bis 25, **dadurch gekennzeichnet, dass** die Vorrichtung eingerichtet ist zum Unterscheiden von Arten der Fortbewegung wie Gehen, Laufen und Skifahren basierend auf den charakteristischen maximalen und minimalen Beschleunigungswerten a_{max} und a_{min} und/oder der Schrittfrequenz.

29. Vorrichtung nach Anspruch 28, **dadurch gekennzeichnet, dass** die Vorrichtung eingerichtet ist zum Ausführen einer individuellen Kalibrierung für jede Art der Fortbewegung wie Laufen, Gehen, Nordic Walking oder Skilanglauf.

30. Vorrichtung nach einem der vorhergehenden Ansprüche 16 bis 29, **dadurch gekennzeichnet, dass** die Vorrichtung eingerichtet ist zur Verwendung in der Schritt-für-Schritt-Navigation.

31. Vorrichtung nach Anspruch 30, **dadurch gekennzeichnet, dass** die Vorrichtung eingerichtet ist zum Zusammenwirken mit einem Höhenmesser, Satellitennavigationsgeräten und/oder einem Magnetometer.

32. Vorrichtung nach Anspruch 30 oder 31, **dadurch gekennzeichnet, dass** die Vorrichtung eingerichtet ist zum Empfangen und/oder Nutzen von Daten von Kartendatenbanken und/oder Daten der Geländeneigung.

33. Vorrichtung nach einem der vorhergehenden Ansprüche 16 bis 32, die dazu eingerichtet ist, in der Mitte des Körpers einer sich bewegenden Person positioniert zu werden.

34. Vorrichtung nach Anspruch 31, **dadurch gekennzeichnet, dass** die Vorrichtung in einem Kleidungsstück, einer Kopfbedeckung, am Hals, in einer Kleidungstasche oder am Gürtel der sich bewegenden Person enthalten ist.

35. System zum Messen der Fortbewegung einer sich bewegenden Person, **dadurch gekennzeichnet, dass** das System eine Vorrichtung nach einem der vorhergehenden Ansprüche 16 bis 34 und eine zum Zusammenwirken mit der Vorrichtung eingerichtete Anzeigeeinheit umfasst.

36. System nach Anspruch 35, **dadurch gekennzeichnet, dass** die Vorrichtung zum Messen der Geschwindigkeit der sich bewegenden Person und die Anzeigeeinheit für die sich bewegende Person in einer Vorrichtung integriert sind.

Revendications

1. Procédé de mesure de la vitesse d'une personne en mouvement, ledit procédé comprenant les étapes consistant à :

mesurer des valeurs de l'accélération verticale du corps de la personne en mouvement pendant des cycles de pas de la personne en mouvement au moyen d'un capteur d'accélération (4) ;
traiter les valeurs mesurées de l'accélération verticale dans une unité d'analyse (5) sur la base

d'un processeur, ledit traitement comprenant l'étape consistant à : filtrer les valeurs mesurées de l'accélération verticale ; également **caractérisé par** les étapes consistant à :

définir, pour les cycles de pas, une valeur d'accélération maximale caractéristique spécifique au cycle de pas a_{max} à partir des valeurs filtrées de l'accélération verticale pendant un demi-cycle positif;
définir, pour les cycles de pas, une valeur d'accélération minimale caractéristique spécifique au cycle de pas a_{min} à partir des valeurs filtrées de l'accélération verticale pendant un demi-cycle négatif;
calculer la vitesse de la personne en mouvement sur la base de la valeur d'accélération maximale caractéristique spécifique au cycle de pas a_{max} ou de la valeur d'accélération minimale caractéristique spécifique au cycle de pas a_{min}.

2. Procédé selon la revendication 1, **caractérisé par** les étapes consistant à:

filtrer numériquement les valeurs mesurées de l'accélération verticale ;
définir, pour les cycles de pas, une valeur d'accélération maximale caractéristique spécifique au cycle de pas a_{max} en tant que moyenne des valeurs filtrées numériquement de l'accélération verticale du corps mesurées pendant le demi-cycle positif;
définir, pour les cycles de pas, une valeur d'accélération minimale caractéristique spécifique au cycle de pas a_{min} en tant que moyenne des valeurs filtrées numériquement de l'accélération verticale du corps mesurées pendant le demi-cycle négatif.

3. Procédé selon la revendication 1, **caractérisé par** les étapes consistant à:

filtrer analogiquement les valeurs mesurées de l'accélération verticale ;
définir, pour les cycles de pas, l'accélération maximale caractéristique spécifique au cycle de pas a_{max} en tant que maximum des valeurs filtrées analogiquement de l'accélération verticale du corps ;
définir, pour les cycles de pas, les accélérations minimales caractéristiques spécifiques au cycle de pas a_{min} en tant que minimum des valeurs filtrées analogiquement de l'accélération verticale du corps.

4. Procédé selon la revendication 1, **caractérisé par** les étapes consistant à
filtrer les valeurs mesurées de l'accélération verticale avec pondération numérique ;
définir, pour les cycles de pas, l'accélération maximale caractéristique spécifique au cycle de pas a_{max} en tant que maximum des valeurs filtrées de l'accélération verticale du corps ;
définir, pour les cycles de pas, les accélérations minimales caractéristiques spécifiques au cycle de pas a_{min} en tant que minimum des valeurs filtrées de l'accélération verticale du corps ;
la fonction utilisée pour ladite pondération numérique étant :

$$a_{out}(n) = (1-k) * a_{out}(n-1) + a_{in} * k,$$

où n indique la n-ème valeur d'échantillonnage et k est un facteur de pondération.

5. Procédé selon la revendication 2, **caractérisé par** l'étape consistant à:
filtrer les valeurs mesurées de l'accélération verticale avec pondération numérique ; la fonction utilisée dans ladite filtration à pondération numérique étant :

$$a_{out}(n) = (1-k) * a_{out}(n-1) + a_{in} * k,$$

où n indique le n-ème échantillonnage et k est un facteur de pondération.

6. Procédé selon l'une des revendications précédentes 1 à 5, **caractérisé par** l'étape consistant à calculer la vitesse v sur la base des valeurs d'accélération maximale caractéristique a_{max} de l'accélération verticale comme suit:

$$v \approx k \cdot \left(\frac{\frac{a_{\max}}{1g} + 1}{T_{step}} - f_{ref} \right),$$

où g est l'accélération due à la pesanteur, f_{ref} est une fréquence de référence, et l'accélération maximale caractéristique a_{max} est la valeur d'accélération maximale caractéristique spécifique au cycle de pas filtrée à une fréquence limite f_0 choisie.

7. Procédé selon l'une des revendications précédentes 1 à 5, **caractérisé par** l'étape consistant à calculer la vitesse v sur la base de la valeur d'accélération minimale caractéristique spécifique au cycle de pas a_{min} de l'accélération verticale comme suit:

$$v \approx k \cdot \sqrt{|a_{\min}|}.$$

8. Procédé selon l'une des revendications 1 à 8, **caractérisé par** les étapes consistant à:

dériver, pour les cycles de pas, un graphe d'accélération à partir des valeurs mesurées de l'accélération verticale du corps;
calculer un temps T_{step} requis pour un cycle de pas en tant qu'intervalle de temps entre des points équivalents sur deux graphes d'accélération, ledit point équivalent étant une valeur maximale dans le graphe d'accélération, une valeur minimale dans le graphe d'accélération ou un point où la valeur dans le graphe d'accélération devient supérieure ou inférieure à une certaine valeur.

9. Procédé selon la revendication 8, **caractérisé par** l'étape consistant à calculer une longueur de pas S_{step} à l'aide de la formule :

$$s_{step} = v * T_{step}.$$

10. Procédé selon la revendication 8 ou 9, **caractérisé par** l'étape consistant à calculer une fréquence de pas f_{step} à l'aide de la formule :

$$f_{step} = 1 / T_{step}.$$

11. Procédé selon la revendication 8, 9 ou 10, **caractérisé par** les étapes consistant à:

détecter un nombre n de poins équivalents sur le graphe d'accélération ;
calculer un nombre de pas n sur la base du nombre n de points équivalents détecté.

12. Procédé selon la revendication 11, **caractérisé par** l'étape consistant à calculer une distance s parcourue par le personne en mouvement en tant que somme des longueurs des pas :

$$s = \sum_{i=1}^{n} s_{step}(i).$$

13. Procédé selon l'une des revendications précédentes 1 à 12, **caractérisé par** l'étape consistant à distinguer les modes de locomotion tels que la marche, la course et le ski sur la base des valeurs d'accélération maximale et minimale caractéristiques a_{max} et a_{min} et/ou de la fréquence de pas.

14. Procédé selon la revendication 13, **caractérisé par** l'étape consistant à effectuer une calibration individuelle pour chaque mode de locomotion.

15. Procédé selon l'une des revendications précédentes 1 à 14, **caractérisé par** l'utilisation du procédé dans une navigation pas à pas.

16. Dispositif de mesure de la vitesse d'une personne en mouvement, **caractérisé en ce que** ledit dispositif comprend :

un capteur d'accélération (4) pour mesurer des valeurs d'accélération verticale du corps pendant des cycles de pas de la personne en mouvement ;
un moyen (5) pour filtrer les valeurs mesurées de l'accélération verticale ;
un moyen (5) pour définir, pour les cycles de pas, une accélération maximale caractéristique spécifique au cycle de pas a_{max} à partir des valeurs filtrées de l'accélération verticale en un demi-cycle positif ;
un moyen (5) pour définir, pour les cycles de pas, une accélération minimale caractéristique a_{min} à partir des valeurs filtrées de l'accélération verticale en un demi-cycle négatif ;
un moyen (5) pour calculer la vitesse de la personne en mouvement sur la base de la valeur d'accélération maximale caractéristique spécifique au cycle de pas a_{max} ou de la valeur d'accélération minimale caractéristique spécifique au cycle de pas a_{min}.

17. Dispositif selon la revendication 16, **caractérisé en ce que** ledit dispositif est également adapté à :

filtrer numériquement les valeurs mesurées de l'accélération verticale ;
définir, pour les cycles de pas, une valeur d'accélération maximale caractéristique spécifique au cycle de pas a_{max} en tant que moyenne des valeurs filtrées numériquement de l'accélération verticale du corps mesurées pendant le demi-cycle positif;
définir, pour les cycles de pas, une valeur d'accélération minimale caractéristique spécifique au cycle de pas a_{min} en tant que moyenne des valeurs filtrées numériquement de l'accélération verticale du corps mesurées pendant le demi-cycle négatif.

18. Dispositif selon la revendication 16, **caractérisé en ce que** ledit dispositif est également adapté à :

filtrer analogiquement les valeurs mesurées de l'accélération verticale ;
définir, pour les cycles de pas, l'accélération

maximale caractéristique spécifique au cycle de pas a_{max} en tant que maximum des valeurs filtrées analogiquement de l'accélération verticale ;

définir, pour les cycles de pas, les accélérations minimales caractéristiques spécifiques au cycle de pas a_{min} en tant que minimum des valeurs filtrées analogiquement de l'accélération verticale.

19. Dispositif selon la revendication 16, **caractérisé en ce que** ledit dispositif est adapté à :

filtrer les valeurs mesurées de l'accélération verticale avec pondération numérique ;

définir, pour les cycles de pas, l'accélération maximale caractéristique spécifique au cycle de pas a_{max} en tant que maximum des valeurs filtrées de l'accélération verticale du corps ;

définir, pour les cycles de pas, les accélérations minimales caractéristiques spécifiques au cycle de pas a_{min} en tant que minimum des valeurs filtrées de l'accélération verticale du corps ;

dans la filtration à pondération numérique, utiliser une fonction :

$$a_{out}(n) = (1-k) * a_{out}(n-1) + a_{in} * k,$$

où n indique le n-ème échantillonnage et k est un facteur de pondération.

20. Dispositif selon la revendication 16, **caractérisé en ce que** ledit dispositif est adapté à filtrer les valeurs mesurées de l'accélération verticale avec pondération numérique et, dans la filtration à pondération numérique, utiliser une fonction :

$$a_{out}(n) = (1-k) * a_{out}(n-1) + a_{in} * k,$$

où n indique le n-ème échantillonnage et k est un facteur de pondération.

21. Dispositif selon l'une des revendications précédentes 16 à 20, **caractérisé en ce que** ledit dispositif est adapté à calculer la vitesse v sur la base des valeurs d'accélération maximale caractéristique a_{max} de l'accélération verticale comme suit :

$$v \approx k \cdot \left(\frac{\frac{a_{\max}}{1g} + 1}{T_{step}} - f_{ref} \right),$$

où g est l'accélération due à la pesanteur, f_{ref} est une fréquence de référence, et a_{max} est l'accélération maximale caractéristique spécifique au cycle de pas filtrée à une fréquence limite f_0 choisie.

22. Dispositif selon l'une des revendications précédentes 16 à 20, **caractérisé en ce que** ledit dispositif est adapté à calculer la vitesse v sur la base des valeurs d'accélération minimale caractéristique a_{min} de l'accélération verticale comme suit :

$$v \approx k \cdot \sqrt{|a_{\min}|}.$$

23. Dispositif selon l'une des revendications précédentes 16 à 22, **caractérisé en ce que** ledit dispositif est adapté à :

dériver, pour les cycles de pas, un graphe d'accélération à partir des valeurs mesurées de l'accélération verticale du corps;

calculer un temps T_{step} requis pour un cycle de pas en tant qu'intervalle de temps entre des points équivalents sur deux graphes d'accélération, ledit point équivalent étant une valeur maximale dans le graphe d'accélération, une valeur minimale dans le graphe d'accélération ou un point où la valeur dans le graphe d'accélération devient supérieure ou inférieure à une certaine valeur.

24. Dispositif selon la revendication 23, **caractérisé en ce que** ledit dispositif est adapté à calculer une longueur de pas S_{step} à l'aide d'une formule :

$$s_{step} = v * T_{step}.$$

25. Dispositif selon la revendication 23 ou 24, **caractérisé en ce que** ledit dispositif est adapté à calculer une fréquence de pas f_{step} à l'aide d'une formule :

$$f_{step} = 1 / T_{step}.$$

26. Dispositif selon la revendication 23, 24 ou 25, **caractérisé en ce que** ledit dispositif est adapté à

détecter un nombre n de poins équivalents sur le graphe d'accélération ;

calculer un nombre de pas n sur la base du nombre n de points équivalents détecté.

27. Dispositif selon l'une des revendications précédentes 24 à 26, **caractérisé en ce que** ledit dispositif est adapté à calculer une distance s parcourue par le personne en mouvement en tant que somme des longueurs de pas :

$$s = \sum_{i=1}^{n} s_{step}(i) \, .$$

28. Dispositif selon l'une des revendications précédentes 16 à 25, **caractérisé en ce que** ledit dispositif est adapté à distinguer les modes de locomotion tel que la marche, la course et le ski sur la base des valeurs d'accélération maximale et minimale caractéristiques a_{max} et a_{min} et/ou de la fréquence de pas.

29. Dispositif selon la revendication 28, **caractérisé en ce que** ledit dispositif est adapté à effectuer une calibration individuelle pour chaque mode de locomotion tel que la course, la marche, la marche nordique ou le ski de fond.

30. Dispositif selon l'une des revendications précédentes 16 à 29, **caractérisé en ce que** ledit dispositif est adapté pour l'utilisation dans une navigation pas à pas.

31. Dispositif selon la revendication 30, **caractérisé en ce que** ledit dispositif est adapté à coopérer avec un altimètre, des dispositifs de navigation par satellite et/ou un magnétomètre.

32. Dispositif selon la revendication 30 ou 31, **caractérisé en ce que** ledit dispositif est adapté à recevoir et/ou utiliser des données d'une base de données cartographiques et/ou des données de pentes de terrains.

33. Dispositif selon l'une des revendications précédentes 16 à 32 adapté à être positionné au milieu du corps d'une personne en mouvement.

34. Dispositif selon la revendication 31, **caractérisé en ce que** ledit dispositif est compris dans un vêtement, dans une coiffure, au cou, dans une poche ou à la ceinture de la personne en mouvement.

35. Système de mesure de la locomotion d'une personne en mouvement, **caractérisé en ce que** le système comprend un dispositif selon l'une des revendications précédentes 16 à 34 et une unité d'affichage adaptée à coopérer avec le dispositif.

36. Système selon la revendication 35, **caractérisé en ce que** ledit dispositif de mesure de la vitesse de la personne en mouvement et ladite unité d'affichage pour la personne en mouvement sont intégrés dans un dispositif.

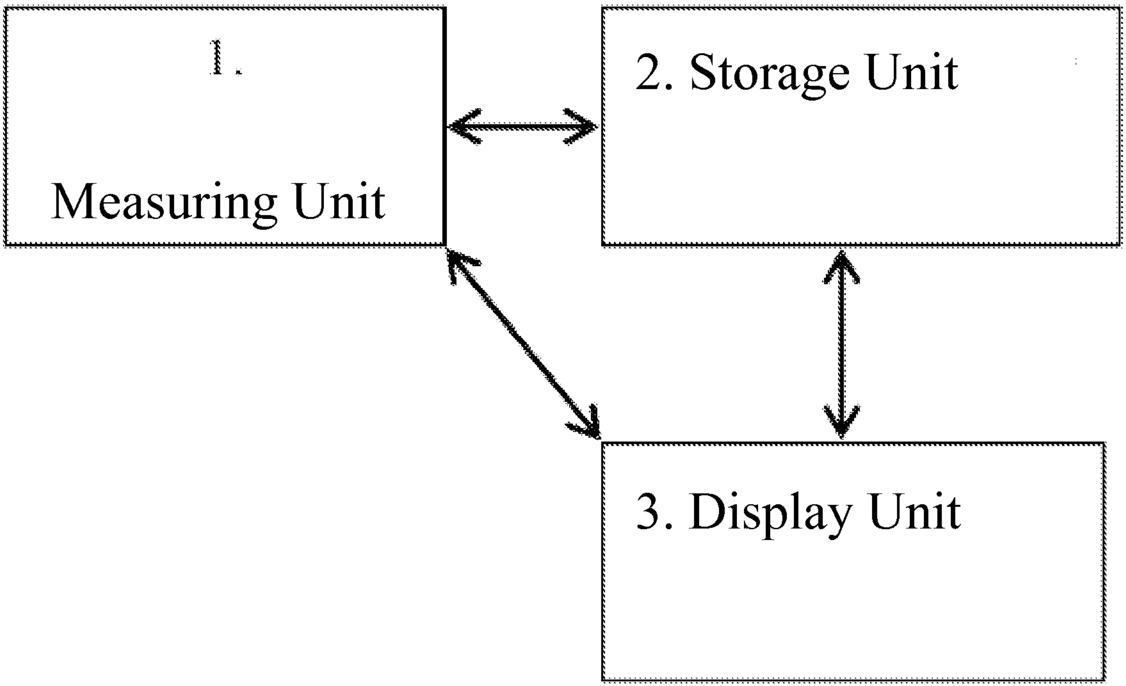

Figure 1

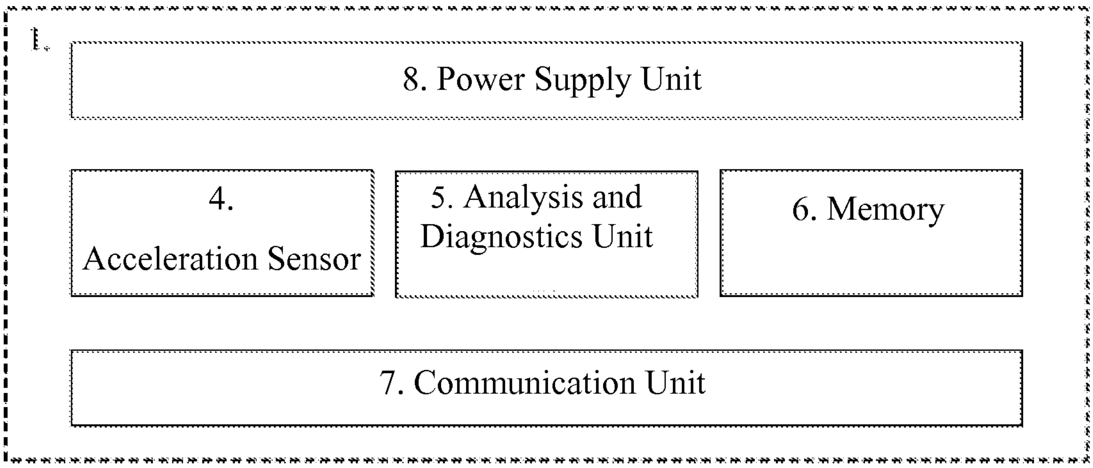

Figure 2

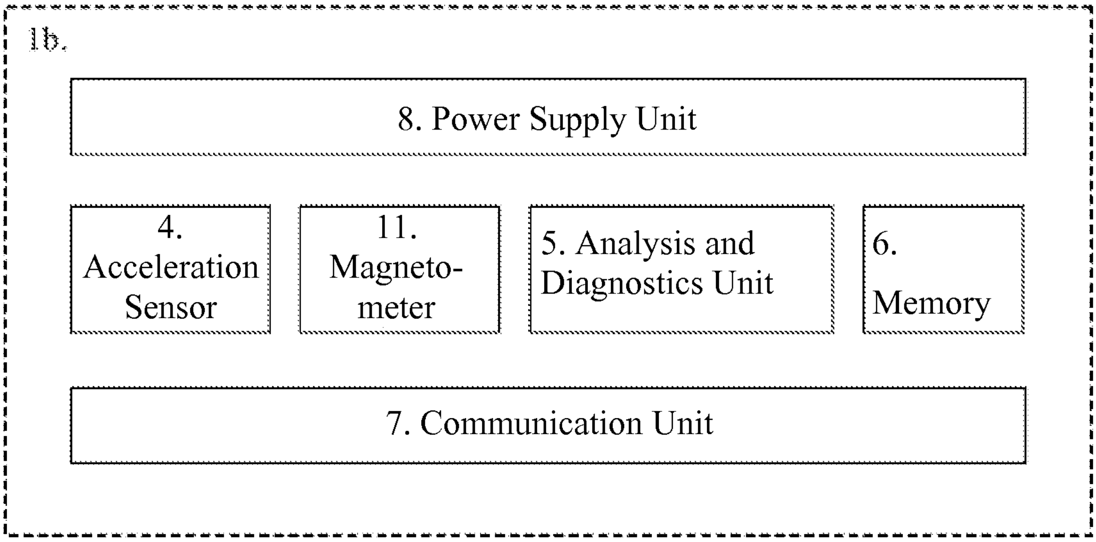
1b.
8. Power Supply Unit
4. Acceleration Sensor
11. Magneto-meter
5. Analysis and Diagnostics Unit
6. Memory
7. Communication Unit

Figure 3

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 4578769 A **[0004]**
- US 20020040601 A **[0006]**
- US 5955667 A **[0006]**
- CA 2218242 **[0006]**
- US 6356856 B **[0008]**
- US 6298314 B **[0009]**
- US 7092846 B **[0010]**
- WO 0020874 A **[0010]**
- US 2007073514 A1 **[0011]**

专利名称(译)	用于测量移动的人的进度的方法和设备		
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当前申请(专利权)人(译)	VTI科技OY		
[标]发明人	MERIHEINA ULF		
发明人	MERIHEINÄ, ULF		
IPC分类号	G01P15/08 G01C21/12 A61B5/11 A61B5/00 A63B24/00 G01C21/10 G01C22/00 G01P3/50 G01P15/00 G01P21/02		
CPC分类号	A61B5/112 A61B5/0002 A61B5/1123 A61B5/6804 A61B5/725 A61B2562/0219 G01C21/10 G01C22/006 G01P3/50 G01P15/00		
优先权	2007005817 2007-11-16 FI 2007005830 2007-11-22 FI 2007005536 2007-07-11 FI		
其他公开文献	EP2165203A1 EP2165203B1		
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摘要(译)

本发明涉及用于物理测量的测量装置，更具体地，涉及用于测量移动的人的进度的方法和装置。在根据本发明的解决方案中，可以基于借助于加速度传感器测量的身体的垂直加速度值以及测量的时间来计算描述移动的人的进展的量。本发明旨在提供一种比现有解决方案更好和更简单的解决方案，用于测量移动人员的进度，该解决方案适用于多种用于各种类型的运动方式的测量解决方案。