EXHIBIT 2

EUROPEAN APPLICATION FILE HISTORY

Europäisches Patentamt
European Patent Office
Office européen des brevets

06832085.2 - 1506 / 1962670 07.12.15

Client Database System (CDS) - clean up.

Application Nr.: 06832085.2

Following clean up action in CDS the entries concerning the **Representative for the applicant** have been amended and are now as follows:

Verweij, Petronella Daniëlle
Philips Intellectual Property & Standards
High Tech Campus 5
5656 AE Eindhoven
NL

Where appropriate, the European Patent Register at www.epo.org/register will be updated to show the amended details.

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Europäisches Patentamt
European Patent Office
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Closure of the procedure in respect of application No. 06832085.2 - 1506 11.07.15

1. The procedure in respect of the above application is closed for the following reason:

REFU 2/01.04.15 The time limit under Art.108 EPC has expired.
No notice of appeal under Article 108 and Rule 99 EPC has been filed. No request for a decision under Rule 112(2), or for further processing under Article 121 EPC or for re-establishment of rights under Article 122 EPC has been filed.

2. The EPASYS situation has been verified in respect of item 1:

DFIL: 05.12.06

NOAP: ////

RDEC: ////

RFPR: //

REES: ///

REFU 3/ADWI 3 and DEAD 1 coded. Date of legal effect 18.03.2015

3. Position regarding fees:

DEST03	005	00613497	15.07.08	EUR	595,00
EXAM02	006	00613497	15.07.08	EUR	1 252,00
FFEE01	020	00613497	15.07.08	EUR	100,00
RFEE 03	033	00503221	05.01.09	EUR	400,00
RFEE 04	034	00503651	04.01.10	EUR	500,00
RFEE 05	035	00504058	03.01.11	EUR	735,00
RFEE 06	036	00504108	02.01.12	EUR	945,00
RFEE 07	037	01144456	02.01.13	EUR	1 105,00
RFEE 08	038	00505049	02.01.14	EUR	1 215,00
RFEE 09	039	00505974	05.01.15	EUR	1 380,00

☒ Examination started on _____ (EXDS51).
☐ Refund(s) ordered:

☐ 75% EXAM fee ☐ DEST fee* ☐ RFEE(s): _____ ☐ Other fees: _____

Note: Attention is to be paid to potential automated refund proposal(s).

*Refund of DEST fee if date of legal effect before/on SEPU date.

4. Mark "DEAD" on the paper file and:

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13-07-2015
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Schulze, Cornelia
Formalities Officer

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Formalities officer: Ms Peggy Willis

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Verweij, Petronella Danielle
Philips Intellectual Property & Standards
P.O. Box 220
5600 AE Eindhoven
PAYS-BAS

10 APR. 2015

EPO - Munich
41
22. Mai 2015

Date
01-04-2015

Reference	Application No./Patent No.
2005P02656WE	06832085.2 - 1506 / 1962670

Applicant/Proprietor
Koninklijke Philips N.V.

EPA/EPO/OEB Formblatt/Form/Formulaire : 2007+2916+2019+clms 12 pages

Empfangsbescheinigung über den Zugang des vorstehend bezeichneten Schriftstücks
Acknowledgement of receipt of the document specified above
Récépissé du document spécifié ci-dessus

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With reference to the Notice in OJ EPO 7/2010, 377, you are requested to date and sign the acknowledgement of receipt and return it to the EPO **immediately**:

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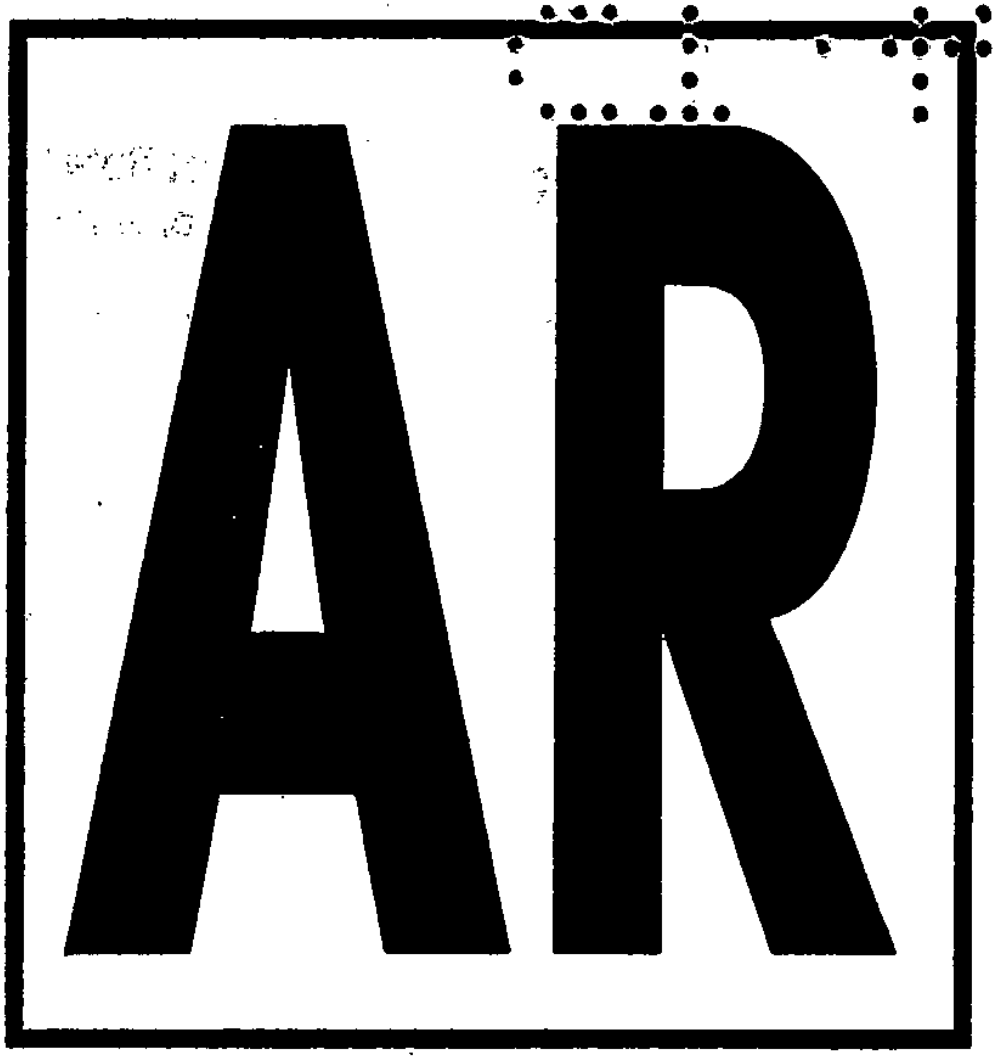

915-005-000 05.05

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Verweij, Petronella Danielle
Philips Intellectual Property & Standards
P.O. Box 220
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PAYS-BAS

Date
17.04.15

Reference	Application No./Patent No.
2005P02656WE	06832085.2 - 1506 / 1962670
Applicant/Proprietor	
Koninklijke Philips N.V.	

Revocation of the automatic debit order

Application No. 06832085.2

The revocation of the automatic debit order for deposit account no. 28090021 was received on 07.04.15.

The automatic debit order for the above application thus ceased to be effective as from that date.

For the Examining Division

PHILIPS

European Patent Office
Patentlaan 2
2288 EE RIJSWIJK

By fax on 7-4-2015

Philips Intellectual Property & Standards

P.O. Box 220
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The Netherlands

EPO - DG 2
09. 04. 2015
49

Ref: NVERW/MDUIN

Email: patent.administration@philips.com
Tel: +31 40 27 40607

Date: 7 April 2015

Subject: European Patent Applications (attached list)

1 .Conditional withdrawal (SDRA) of Applications
2. Unconditional withdrawal of automatic debit order (DECA)
3. Unconditional withdrawal of (auxiliary) request for oral proceedings.

I hereby withdraw the EP Patent Applications indicated in the attached list, on the condition that any fee is refunded. It is understood that if no refund is possible, the application is not withdrawn.

The automatic debit order from deposit account 28090021 is herewith unconditionally revoked.

If, for any of these Applications, an (auxiliary) request for oral proceedings is pending, said request is herewith withdrawn. In case summons to oral proceedings have already been issued, the European patent office is hereby informed that the Applicant will not attend the oral proceedings, and requested to take a decision on the state of the file.

The Professional Representative,

P.D. Verweij

Internal file number	Filing date	Application number	Applicant / Name
1999P01232WE 01	2000-feb-28	07119844.4	Koninklijke Philips N.V.
2001P01182WE	2002-apr-02	02722552.3	Koninklijke Philips N.V.
2002P03137WE 01	2003-dec-05	07113171.8	Koninklijke Philips N.V.
2003P03094WE	2004-sep-02	04782897.5	RIC Investments, LLC
2004P01497WE	2005-jun-21	05747664.0	Koninklijke Philips N.V.
2004P03255WE	2005-aug-02	05779421.6	Discus Dental, LLC
2005P00364WE	2006-mrt-06	06711025.4	Koninklijke Philips N.V.; Philips Intellectual Property & Standards GmbH
2005P02656WE	2006-dec-05	06832085.2	Koninklijke Philips N.V.
2005P03215WE	2006-apr-04	06749403.9	Respironics Oxytec, Inc.
2006P00408WE	2007-feb-15	07705893.1	Koninklijke Philips N.V.
2006P00588WE	2007-jun-13	07798500.0	Koninklijke Philips N.V.
2006P02742WE	2007-apr-02	07759975.1	Respironics, Inc.
2008P01421WE	2009-dec-07	09793600.9	Koninklijke Philips N.V.; Philips Intellectual Property & Standards GmbH
2009P00342WE	2010-mrt-24	10712982.7	Koninklijke Philips N.V.
2009P00594WE	2010-jun-10	10728352.5	Koninklijke Philips N.V.
2009P00750WE	2010-sep-17	10775889.8	Koninklijke Philips N.V.
2010P00184WE	2011-feb-24	11709497.9	Koninklijke Philips N.V.
2010P00214WE	2011-feb-04	11706356.0	Koninklijke Philips N.V.; Philips Intellectual Property & Standards GmbH
2010P00292WE	2011-jan-28	11706015.2	Koninklijke Philips N.V.; Philips Intellectual Property & Standards GmbH
2010P00591WE	2011-jul-08	11744080.0	Koninklijke Philips N.V.
2010P00728WE	2011-jun-21	11734182.6	Koninklijke Philips N.V.
2010P01069WE	2011-nov-16	11799322.0	Koninklijke Philips N.V.
2011P00983WE	2012-aug-17	12778793.5	Koninklijke Philips N.V.
2011P01017WE	2012-sep-14	12783662.5	Koninklijke Philips N.V.
2011P01134WE	2012-okt-03	12787881.7	Koninklijke Philips N.V. Philips Deutschland GmbH
2011P01803WE	2012-nov-15	12818813.3	Koninklijke Philips N.V.
2011P01820WE	2013-feb-08	13713237.9	Koninklijke Philips N.V.; University Hospitals Medical Group, Inc.; Case Western Reserve University (CWRU)
2012P00498WE	2013-mrt-20	13722831.8	Koninklijke Philips N.V. Philips Deutschland GmbH
2012P00714WE	2013-aug-13	13783988.2	Koninklijke Philips N.V.

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Ref: NVERW/MDUIN

Email: patent.administration@philips.com
Tel: +31 40 27 40607

Date: 7 April 2015

Subject: European Patent Applications (attached list)

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The Professional Representative,

P.D. Verweij

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Verweij, Petronella Danielle
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PAYS-BAS

Date
01-04-2015

Reference	Application No./Patent No.
2005P02656WE	06832085.2 - 1506 / 1962670

Applicant/Proprietor
Koninklijke Philips N.V.

EPA/EPO/OEB Formblatt/Form/Formulaire : 2007+2916+2019+clms 12 pages

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PF30285

AMENDED SET OF CLAIMS:

1. A measuring system (1) comprising

- a sensor (6) arranged to be attached at a plurality of body parts of a subject for obtaining a measured value representing a physical or a physiological quantity of the subject at a body part to which the sensor is attached,

- means for deriving a subject-related value from the measured value in dependence on which body part the sensor is attached to,

characterized in the measuring system further comprising

- means for determining on which body part of the subject the sensor is attached to.

2. The measuring system (1) according to claim 1, wherein the plurality of body parts includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head.

3. The measuring system (1) according to claim 1, wherein the derived value comprises an activity parameter of the subject,
the activity parameter comprising energy expenditure.

4. The measuring system (1) according to claim 1, wherein the activity parameter represents a degree of activity of the body part the sensor is attached to.

5. The measuring system (1) according to claim 1, wherein the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration.

6. The measuring system (1) according to claim 1, further comprising means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on which body part of the subject the sensor is attached to, and the

sensor is arranged for generating a further measured value for each quantity in the selected subset.

7. The measuring system (1) according to claim 1, further comprising

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

8. The measuring system (1) according to claim 1, wherein the means for determining to which body part the sensor is attached is arranged for performing the determining in dependence on the measured value.

9. The measuring system (1) according to claim 8, further comprising means for obtaining from the sensor (6) a plurality of measured values measured during a time interval, and wherein the means for determining to which body part the sensor is attached is arranged for performing the determining in dependence on the measured values measured during the time interval.

10. The measuring system (1) according to claim 8 or 9, wherein the means for determining to which body part the sensor (6) is attached is arranged for performing the determining on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively.

11. The measuring system (1) according to claim 9, wherein the means for determining to which body part the sensor (6) is attached comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval.

12. The measuring system (1) according to claim 8 or 9, further comprising means for determining that the user is performing a standardized activity, and wherein the means for determining to which body partthe sensor is attached is arranged for using at least one measured value obtained from the sensor (6), the measured value relating to a time the user is performing the standardized activity.

13. The measuring system (1) according to claim 1, further comprising a user interface for receiving input from a user related to which body part of the subject the sensor is attached to.

14. The measuring system (1) according to claim 1, further comprising

- means for establishing that the subject is performing a predetermined activity,

- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,

- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and

- means for providing feedback in dependence on the similarity measure.

15. A system for determining the calorie balance of a subject, the system comprising the measuring system (1) according to claim 4, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure.

16. A method of estimating a derived value relating to a subject, the method comprising

- obtaining at least one measured value from a sensor (6) attached to a body part of the subject, the measured value representing a physical or a physiological quantity of the subject at the body part to which the sensor is attached, and

- determining which body part the sensor is attached to, and

- deriving the subject-related value from the measured value also in dependence on which body part the sensor is attached to.

AMENDED SET OF CLAIMS:

1. A measuring system (1) comprising

- an accelerometer (6) arranged to be attached at a plurality of body parts of a subject for obtaining a measured value representing a physical or a physiological quantity of the subject at a body part to which the accelerometer is attached,

- means for deriving a subject-related value from the measured value in dependence on which body part the accelerometer is attached to,

characterized in the measuring system further comprising

- means for determining on which body part of the subject the accelerometer is attached to.

2. The measuring system (1) according to claim 1, wherein the plurality of body parts includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head.

3. The measuring system (1) according to claim 1, wherein the derived value comprises an activity parameter of the subject,
the activity parameter comprising energy expenditure.

4. The measuring system (1) according to claim 1, wherein the activity parameter represents a degree of activity of the body part the accelerometer is attached to.

5. The measuring system (1) according to claim 1, wherein the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration.

6. The measuring system (1) according to claim 1, further comprising means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on which body part of the subject the accelerometer is attached to, and

the accelerometer is arranged for generating a further measured value for each quantity in the selected subset.

7. The measuring system (1) according to claim 1, further comprising

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

8. The measuring system (1) according to claim 1, wherein the means for determining to which body part the accelerometer is attached is arranged for performing the determining in dependence on the measured value.

9. The measuring system (1) according to claim 8, further comprising means for obtaining from the accelerometer (6) a plurality of measured values measured during a time interval, and wherein the means for determining to which body part the accelerometer is attached is arranged for performing the determining in dependence on the measured values measured during the time interval.

10. The measuring system (1) according to claim 8 or 9, wherein the means for determining to which body part the accelerometer (6) is attached is arranged for performing the determining on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively.

11. The measuring system (1) according to claim 9, wherein the means for determining to which body part the accelerometer (6) is attached comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval.

12. The measuring system (1) according to claim 8 or 9, further comprising means for determining that the user is performing a standardized activity, and wherein the means for determining to which body part the accelerometer is attached is arranged for using at least one measured value obtained from the accelerometer (6), the measured value relating to a time the user is performing the standardized activity.

13. The measuring system (1) according to claim 1, further comprising a user interface for receiving input from a user related to which body part of the subject the accelerometer is attached to.

14. The measuring system (1) according to claim 1, further comprising

- means for establishing that the subject is performing a predetermined activity,

- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,

- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and

- means for providing feedback in dependence on the similarity measure.

15. A system for determining the calorie balance of a subject, the system comprising the measuring system (1) according to claim 4, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure.

16. A method of estimating a derived value relating to a subject, the method comprising

- obtaining at least one measured value from an accelerometer (6) attached to a body part of the subject, the measured value representing a physical or a physiological quantity of the subject at the body part to which the accelerometer is attached, and

- determining which body part the accelerometer is attached to, and

- deriving the subject-related value from the measured value also in dependence on which body part the accelerometer is attached to.

AMENDED SET OF CLAIMS:

1. A measuring system (1) comprising

- a sensor (6) arranged to be attached at a plurality of body parts of a subject for obtaining a measured value representing a physical or a physiological quantity of the subject at a body part to which the sensor is attached,

- means for deriving a subject-related value from the measured value in dependence on which body part the sensor is attached to,

characterized in the measuring system further comprising

- means for determining on which body part of the subject the sensor is attached to by analyzing on the basis of a predefined set of rules related to the measured value a signal from the sensor for features that are position dependent.

2. The measuring system (1) according to claim 1, wherein the plurality of body parts includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head.

3. The measuring system (1) according to claim 1, wherein the derived value comprises an activity parameter of the subject,
the activity parameter comprising energy expenditure.

4. The measuring system (1) according to claim 1, wherein the activity parameter represents a degree of activity of the body part the sensor is attached to.

5. The measuring system (1) according to claim 1, wherein the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration.

6. The measuring system (1) according to claim 1, further comprising means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on which body part of the subject the sensor is attached to, and the

sensor is arranged for generating a further measured value for each quantity in the selected subset.

7. The measuring system (1) according to claim 1, further comprising

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

8. The measuring system (1) according to claim 1, wherein the means for determining to which body part the sensor is attached is arranged for performing the determining in dependence on the measured value.

9. The measuring system (1) according to claim 8, further comprising means for obtaining from the sensor (6) a plurality of measured values measured during a time interval, and wherein the means for determining to which body part the sensor is attached is arranged for performing the determining in dependence on the measured values measured during the time interval.

10. The measuring system (1) according to claim 9, wherein the means for determining to which body part the sensor (6) is attached is arranged for performing the determining on the basis of a predefined set of rules related to the measured values measured during the time interval.

11. The measuring system (1) according to claim 9, wherein the means for determining to which body part the sensor (6) is attached comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval.

12. The measuring system (1) according to claim 8 or 9, further comprising means for determining that the user is performing a standardized activity, and wherein the means for determining to which body part the sensor is attached is arranged for using at least one measured value obtained from the sensor (6), the measured value relating to a time the user is performing the standardized activity.

13. The measuring system (1) according to claim 1, further comprising a user interface for receiving input from a user related to which body part of the subject the sensor is attached to.

14. The measuring system (1) according to claim 1, further comprising

- means for establishing that the subject is performing a predetermined activity,

- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,

- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and

- means for providing feedback in dependence on the similarity measure.

15. A system for determining the calorie balance of a subject, the system comprising the measuring system (1) according to claim 4, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure.

16. A method of estimating a derived value relating to a subject, the method comprising

- obtaining at least one measured value from a sensor (6) attached to a body part of the subject, the measured value representing a physical or a physiological quantity of the subject at the body part to which the sensor is attached, and

- determining which body part the sensor is attached to by analyzing on the basis of a predefined set of rules related to the measured value a signal from the sensor for features that are position dependent, and

- deriving the subject-related value from the measured value also in dependence on which body part the sensor is attached to.

AMENDED SET OF CLAIMS:

1. A measuring system (1) comprising

- an accelerometer (6) arranged to be attached at a plurality of body parts of a subject for obtaining a measured value representing a physical or a physiological quantity of the subject at a body part to which the accelerometer is attached,

- means for deriving a subject-related value from the measured value in dependence on which body part the accelerometer is attached to,

characterized in the measuring system further comprising

- means for determining on which body part of the subject the accelerometer is attached to by analyzing on the basis of a predefined set of rules related to the measured value a signal from the accelerometer for features that are position dependent.

2. The measuring system (1) according to claim 1, wherein the plurality of body parts includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head.

3. The measuring system (1) according to claim 1, wherein the derived value comprises an activity parameter of the subject,
the activity parameter comprising energy expenditure.

4. The measuring system (1) according to claim 1, wherein the activity parameter represents a degree of activity of the body part the accelerometer is attached to.

5. The measuring system (1) according to claim 1, wherein the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration.

6. The measuring system (1) according to claim 1, further comprising means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on which body part of the subject the accelerometer is attached to, and

the accelerometer is arranged for generating a further measured value for each quantity in the selected subset.

7. The measuring system (1) according to claim 1, further comprising

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

8. The measuring system (1) according to claim 1, wherein the means for determining to which body part the accelerometer is attached is arranged for performing the determining in dependence on the measured value.

9. The measuring system (1) according to claim 8, further comprising means for obtaining from the accelerometer (6) a plurality of measured values measured during a time interval, and wherein the means for determining to which body part the accelerometer is attached is arranged for performing the determining in dependence on the measured values measured during the time interval.

10. The measuring system (1) according to claim 8 or 9, wherein the means for determining to which body part the accelerometer (6) is attached is arranged for performing the determining on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively.

11. The measuring system (1) according to claim 9, wherein the means for determining to which body part the accelerometer (6) is attached comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval.

12. The measuring system (1) according to claim 8 or 9, further comprising means for determining that the user is performing a standardized activity, and wherein the means for determining to which body part the accelerometer is attached is arranged for using at least one measured value obtained from the accelerometer (6), the measured value relating to a time the user is performing the standardized activity.

13. The measuring system (1) according to claim 1, further comprising a user interface for receiving input from a user related to which body part of the subject the accelerometer is attached to.

14. The measuring system (1) according to claim 1, further comprising

- means for establishing that the subject is performing a predetermined activity,

- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,

- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and

- means for providing feedback in dependence on the similarity measure.

15. A system for determining the calorie balance of a subject, the system comprising the measuring system (1) according to claim 4, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure.

16. A method of estimating a derived value relating to a subject, the method comprising

- obtaining at least one measured value from an accelerometer (6) attached to a body part of the subject, the measured value representing a physical or a physiological quantity of the subject at the body part to which the sensor is attached, and

- determining which body part the accelerometer is attached to, and

- deriving the subject-related value from the measured value also in dependence on which body part the accelerometer is attached to.

The objections raised in the summons were discussed.

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European Patent Office
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GERMANY
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Fax: +49 30 2590 1840

Application No.: 06 832 085.2

Decision of the Examining Division

In the oral proceedings held on 18.03.2015, the examining division has decided:

The European patent application is refused on the basis of Article 97(2) EPC. The reasons for the decision are attached (Form(s) 2916).

24.3.2015
Date

Jonsson, P.O.
Chairman

Clevorn, Jens
1st examiner

Pohjamo, Terhi
2nd examiner

Enclosure(s): Form 2916
claims, 12 sheets

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Verweij, Petronella Danielle
Philips Intellectual Property & Standards
P.O. Box 220
5600 AE Eindhoven
PAYS-BAS

Formalities Officer
Name: Willis, Peggy
Tel: +49 30 25901 - 749
or call
+31 (0)70 340 45 00

Substantive Examiner
Name: Clevorn, Jens
Tel: +49 30 25901 - 556

Application No.	Ref.	Date
06 832 085.2 - 1506	2005P02656WE	01.04.2015
Applicant: Koninklijke Philips N.V.		

Decision to refuse a European Patent application

The Examining Division - at the oral proceedings dated 18.03.2015 - has decided:

European Patent application No. 06 832 085.2 is refused.

Applicant/s:
Koninklijke Philips N.V.
High Tech Campus 5
5656 AE Eindhoven
NL

Title
DETECTION AND COMPENSATION METHOD FOR
MONITORING THE PLACE OF ACTIVITY ON THE BODY

The grounds for the decision are set out on the supplemental sheets annexed hereto.

Means of redress

This decision is open to appeal.
Attention is drawn to the attached text of Articles 106 to 108 EPC and Rules 97 and 98 EPC.

Registered letter with advice of delivery
EPO Form 2007 12.07TRI

Examining Division:

Chairman:	Jonsson, P.O.
2nd Examiner:	Pohjamo, Terhi
1st Examiner:	Clevorn, Jens

Willis, Peggy
Formalities Officer
Tel. No.: +49 30 25901-749 **Berlin sub-office**

Enclosure(s): 6 page/s reasons (Form 2916)
Form 2019
claims, 12 sheets

to EPO postal service: 27.03.15

Datum / Date / Date: 01.04.2015
Blatt / Sheet / Feuille: 1
Anmelde-Nr: / Application No: 06 832 085.2 / Demande n°:

Summary of Facts and Submissions

1 European patent application No. 06 832 085.2 having the title "DETECTION AND COMPENSATION METHOD FOR MONITORING THE PLACE OF ACTIVITY ON THE BODY" was filed on 05-12-2006 as PCT 2006 IB 05499. It claims priority of EP 05112250 filed on 15-12-2005. The applicant is
Koninklijke Philips N.V.
High Tech Campus 5
5656 AE Eindhoven
NL.

2 The first communication of the examining division made reference to the documents

D1 US 5 111 826 A (NASIFF ROGER E [US]) 12 May 1992 (1992-05-12)

D2 EP 1 254 629 A1 (OMRON TATEISI ELECTRONICS CO [JP] OMRON HEALTHCARE CO LTD [JP]) 6 November 2002 (2002-11-06)

D3 US 2003/065257 A1 (MAULT JAMES R [US] ET AL) 3 April 2003 (2003-04-03)

and raised objections i.a. under Articles 123(2), 52(1), 54(1) and (2) and 56 EPC.

3 In the response received on 27-01-2010 the applicant requested further examination on an amended set of claims and provided arguments in support of the patentability of these claims.

4 In a communication under Article 94(3) EPC issued by the examining division on 19-08-2009, objections i.a. under Articles 123(2), 52(1), 54(1) and (2), 83 and 84 EPC were raised.

5 In the response received on 22-12-2010 the applicant requested further examination and provided arguments in support of the patentability of amended sets of claims.

6

7 On 30-06-2014 the examining division issued a summons to attend oral proceedings on 18.03.2015. In the annex to the summons, objections i.a. under Articles 52(1), 54(1) and (2), 83 and 84 EPC were raised.

The following documents were cited:

D4 US 2006/112754 A1 (YAMAMOTO HIROSHI [JP] ET AL) 1 June 2006 (2006-06-01)

D5 WO 2004/091400 A1 (MATSUSHITA ELECTRIC IND CO LTD) 28 October 2004 (2004-10-28)

8 On 18.03.2015, oral proceedings were held in applicant's absence. During the oral proceedings, the objections raised in the summons were discussed.

Since there is no allowable set of claims on file, the application was refused (Art. 97(2)).

9 The decision is based on the following request(s):

Main Request

Description, Pages

1, 2, 4, 5, 7, 9-15	filed on	27-01-2010
3, 6, 6a, 8	filed on	22-12-2010

Claims, Numbers

1-16	filed on	22-12-2010

Drawings, Sheets

1/5-5/5 as published

Auxiliary Request 1

Description, Pages

1, 2, 4, 5, 7, 9-15	filed on	27-01-2010
3, 6, 6a, 8	filed on	22-12-2010

Claims, Numbers

1-16	filed on	22-12-2010

Drawings, Sheets

1/5-5/5 as published

Auxiliary Request 2

Description, Pages

1, 2, 4, 5, 7, 9-15	filed on	27-01-2010
3, 6, 6a, 8	filed on	22-12-2010

Claims, Numbers

1-16	filed on	22-12-2010

Drawings, Sheets

1/5-5/5 as published

Auxiliary Request 3

Description, Pages

1, 2, 4, 5, 7, 9-15	filed on	27-01-2010
3, 6, 6a, 8	filed on	22-12-2010

Claims, Numbers

1-16	filed on	22-12-2010

Drawings, Sheets

1/5-5/5	as published

The claims under consideration are attached to this decision. As to the other application documents, reference is made to the file.

REASONS FOR THE DECISION

1 The division can take this decision, since the applicant had had sufficient opportunity to comment on the objections (Art. 113(1) EPC).

Third auxiliary request

2 The present application does not meet the requirements of Article 52(1) EPC because the subject-matter of claims 1 and 16 is not new within the meaning of Article 54(1) and (2) EPC.

2.1 D5 was published before the priority date of the present application, but in Japanese language. D4 is a translation thereof and was published in English, thus the passages mentioned below refer to D4.

2.2 D4 discloses

A measuring system (figures 6 and 7) comprising
- an accelerometer (11) arranged to be attached at a plurality of body parts of a subject for obtaining a measured value representing a physical or a physiological quantity of the subject at a body part to which the accelerometer is attached (paragraphs 44 and 70),
- means (12) for deriving a subject-related value from the measured value in dependence on which body part the accelerometer is attached to (paragraph 71)
- means (32; paragraph 70) for determining on which body part of the subject the accelerometer is attached to by analyzing on the basis of a predefined set of rules related to the measured value a signal from the accelerometer for features that are position dependent.

The subject-matter of claim 1 is thus not novel over D5.

2.3 The subject-matter of claim 16 is not novel mutatis mutandis.

3 Claims 1 and 16 are not supported by the description as required by Article 84 EPC, as its scope is broader than justified by the description and drawings, see also Guidelines F-IV 6.3.

The objection on lack of support also results in an objection under Art. 83, see Guidelines F-IV 6.4, for the same reasons.

The applicant has provided a particular example in figure 6 and corresponding description for determining the body part on which the sensor is attached. Additionally, sensor positions were mentioned on page 4, paragraph 3. In order to fulfill the requirements of Art. 83, the particular example must enable person skilled in the art to perform the invention over the whole range claimed, which covers any body part. However, while the division believes that sensor positions such as those mentioned on page 4, paragraph 3 can well be distinguished based on accelerometer signals, this is not the case for body parts such as the ring finger and the index finger, due to their like anatomy, e.g. like range of movements and like dimensions.

See also Guidelines F-III 1.

Main request and auxiliary requests one and two

4 The subject-matter of claims 1 and 16 of the main, 1st and 2nd auxiliary requests is broader than the subject-matter of claims 1 and 16 of the third auxiliary request and thus also does not fulfill the requirement of novelty (Art. 52(1), 54(1) and (2)).

5 The subject-matter of claims 1 and 16 of the main, 1st and 2nd auxiliary requests is broader than the subject-matter of claims 1 and 16 of the third auxiliary request and thus also does not fulfill the requirements of Article 83 and 84.

Conclusion

6 Since there is no allowable set of claims on file, the patent application is refused under Article 97(2) EPC.

Article 106
Decisions subject to appeal

(1) An appeal shall lie from decisions of the Receiving Section, Examining Divisions, Opposition Divisions and the Legal Division. It shall have suspensive effect.

(2) A decision which does not terminate proceedings as regards one of the parties can only be appealed together with the final decision, unless the decision allows a separate appeal.

(3) The right to file an appeal against decisions relating to the apportionment or fixing of costs in opposition proceedings may be restricted in the Implementing Regulations.

Rule 97
Appeal against apportionment and fixing of costs

(1) The apportionment of costs of opposition proceedings cannot be the sole subject of an appeal.

(2) A decision fixing the amount of costs of opposition proceedings cannot be appealed unless the amount exceeds that of the fee for appeal.

Rule 98
Surrender or lapse of the patent

The decision of an Opposition Division may be appealed even if the European patent has been surrendered in all the designated Contracting States or has lapsed in all those States.

Article 107
Persons entitled to appeal and to be parties to appeal proceedings

Any party to proceedings adversely affected by a decision may appeal. Any other parties to the proceedings shall be parties to the appeal proceedings as of right.

Article 108
Time limit and form

Notice of appeal shall be filed, in accordance with the Implementing Regulations, at the European Patent Office within **two months** of notification of the decision. Notice of appeal shall not be deemed to have been filed until the fee for appeal has been paid. Within **four months** of notification of the decision, a statement setting out the grounds of appeal shall be filed in accordance with the Implementing Regulations.

Further information concerning the filing of an appeal

(a) Notice of appeal can be filed in accordance with Rule 1 and Rule 2(1) EPC, by delivery by hand, by post, or by technical means of communication. The filing has to comply with the details and conditions and, where appropriate, any special formal or technical requirements laid down by the President of the European Patent Office (R. 99(3) EPC).

(b) The addresses of the filing offices of the European Patent Office are as follows:

(i) European Patent Office
D-80298 Munich
Germany

Fax: +49 89 2399-4465

(ii) European Patent Office
Postbus 5818
NL-2280 HV Rijswijk (ZH)
The Netherlands

Fax: +31 70 340-3016

(iii) European Patent Office
D-10958 Berlin
Germany

Fax: +49 30 259 01-840

(c) The notice of appeal must contain the name and address of the appellant in accordance with the provisions of Rule 41(2)(c) EPC, an indication of the decision impugned, and a request defining the subject of the appeal. In the statement of grounds of appeal the appellant shall indicate the reasons for setting aside the decision impugned, or the extent to which it is to be amended, and the facts and evidence on which the appeal is based (R. 99(1) and (2) EPC). The notice of appeal and any subsequent submissions stating the grounds for appeal must be signed (R. 50(3) EPC).

(d) The fee for appeal is laid down in the Rules relating to Fees. The schedule of fees and expenses of the EPO or a reference to the current version is regularly published in the Official Journal of the European Patent Office under the heading "Guidance for the payment of fees, expenses and prices". Fee information is also published on the EPO website under www.epo.org/ fees.

After deliberation of the examining division, the chairman announced the following **decision**:

"The European patent application is refused."

Regarding the reasons for the decision, the chairman referred to:

Article 97(2) EPC: the application does not meet the requirements of Articles 52(1), 54(1) and (2), 83, 84 EPC.

The chairman **closed the proceedings** on 18.03.2015 at 09:45 hours.

Jonsson, P.O.
Chairman

Pohjamo, Terhi
Minute Writer

Annex(es):

Europäisches Patentamt
European Patent Office
Office européen des brevets

European Patent Office
10958 BERLIN
GERMANY
Tel: +49 30 2590 10
Fax: +49 30 2590 1840

Application No. : 06 832 085.2

Minutes of the oral proceedings before the EXAMINING DIVISION

The proceedings were not public.

Proceedings opened on 18.03.2015 at 09:15 hours

Examining Division:

Chairman:	Jonsson, P.O.
1st member:	Clevorn, Jens
2nd member:	Pohjamo, Terhi
Minute writer:	Pohjamo, Terhi

Present as/for the applicant/s:

Nobody had appeared for the applicant/s. The chairman confirmed that the applicant/s had been duly summoned.

Essentials of the oral proceedings and the relevant statements of the applicant/s:

Europäisches Patentamt
European Patent Office
Office européen des brevets

EPO - Munich
27
25. Juli 2014

European Patent Office
80298 MUNICH
GERMANY

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Formalities officer: Ms Peggy Willis

Please specify the name of the formalities officer when contacting Customer Services by contact form or phone.

Verweij, Petronella Danielle
Philips Intellectual Property & Standards
P.O. Box 220
5600 AE Eindhoven
PAYS-BAS

07 JULI 2014

Date: 30-06-2014

Reference	Application No./Patent No.
2005P02656WE	06832085.2 - 1506 / 1962670
Applicant/Proprietor: Koninklijke Philips N.V.	

EPA/EPO/OEB Formblatt/Form/Formulaire : 2008+2906

Empfangsbescheinigung über den Zugang des vorstehend bezeichneten Schriftstücks
Acknowledgement of receipt of the document specified above
Récépissé du document spécifié ci-dessus

Unter Bezugnahme auf die Mitteilung im ABl EPA 7/2010, 377 wird gebeten, die Empfangsbescheinigung mit Empfangsdatum und Unterschrift zu versehen und **umgehend** an das EPA zurückzusenden:

With reference to the Notice in OJ EPO 7/2010, 377, you are requested to date and sign the acknowledgement of receipt and return it to the EPO **immediately**:

Conformément au communiqué paru au JO OEB 7/2010, 377, vous êtes prié d'indiquer sur le récépissé la date de réception du document, de signer le récépissé et de le renvoyer **sans délai** à l' OEB:

- **über die Online-Dienste des EPA** (als Anlage zu EPA Form 1038) / **through EPO Online Services** (as annex to EPO Form 1038) / **par les services en ligne de l'OEB** (en tant que pièce jointe au formulaire OEB 1038),
- **per Fax / by fax / par téléfax (+49 (0) 89 2399-4465 or +31 (0) 70 340-3016)**
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5600 AE Eindhoven PAYS-BAS

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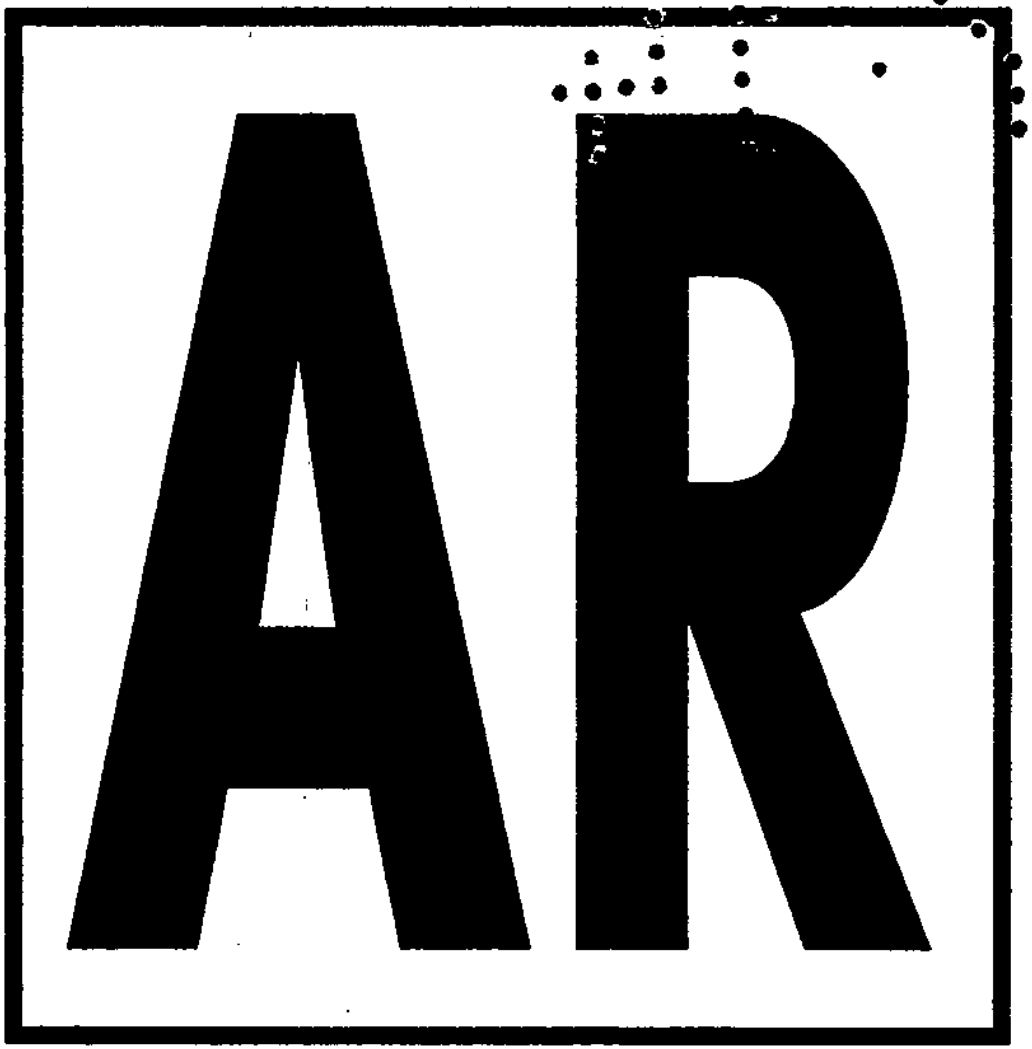

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GERMANY

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Formalities officer: Ms Peggy Willis

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Philips Intellectual Property & Standards
P.O. Box 220
5600 AE Eindhoven
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Date: 30-06-2014

Reference	Application No./Patent No.
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Applicant/Proprietor: Koninklijke Philips N.V.

EPA/EPO/OEB Formblatt/Form/Formulaire : 2008+2906

Empfangsbescheinigung über den Zugang des vorstehend bezeichneten Schriftstücks
Acknowledgement of receipt of the document specified above
Récépissé du document spécifié ci-dessus

Unter Bezugnahme auf die Mitteilung im ABl EPA 7/2010, 377 wird gebeten, die Empfangsbescheinigung mit Empfangsdatum und Unterschrift zu versehen und **umgehend** an das EPA zurückzusenden:

With reference to the Notice in OJ EPO 7/2010, 377, you are requested to date and sign the acknowledgement of receipt and return it to the EPO **immediately**:

Conformément au communiqué paru au JO OEB 7/2010, 377, vous êtes prié d'indiquer sur le récépissé la date de réception du document, de signer le récépissé et de le renvoyer **sans délai** à l' OEB:

- **über die Online-Dienste des EPA** (als Anlage zu EPA Form 1038) / **through EPO Online Services** (as annex to EPO Form 1038) / **par les services en ligne de l'OEB** (en tant que pièce jointe au formulaire OEB 1038),
- **per Fax / by fax / par téléfax (+49 (0) 89 2399-4465 or +31 (0) 70 340-3016)**
- oder per Post / or by post / ou par courrier.

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Europäisches Patentamt
80298 MÜNCHEN
DEUTSCHLAND

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EPA/EPO/OEB Form 2936 08.10

Oral proceedings are summoned at the request of the applicant in the letter dated 22.12.2010 and because the Examining Division considers it to be expedient in the present case (Art. 116 EPC).

This summons is based on the sets of claims filed on 22.12.2010.

The applicant should be aware that a decision pursuant to Article 97 EPC and Rule 111(1) EPC will be given at oral proceedings so that no submissions subsequent to oral proceedings will be accepted. If it is intended to submit further evidence or further claims, pursuant to Rule 116 EPC, the final date for making any written submissions in preparation for the oral proceedings is indicated on the cover sheet of this communication.

If amendments are filed before the oral proceedings, applicant's notice is drawn to the notice from the European Patent Office concerning non-attendance of oral proceedings before the examining division published in the Official Journal 10/2008, p. 471.

At least the following points will be discussed during the proceedings:

1 The objections under Art. 83 and 84 are maintained for the following reasons:

1.1 3rd auxiliary request

The applicant has provided a particular example in figure 6 and corresponding description for determining the body part on which the sensor is attached. Additionally, sensor positions were mentioned on page 4, paragraph 3. In order to fulfill the requirements of Art. 83, the particular example must enable person skilled in the art to perform the invention over the whole range claimed, which covers any body part. However, while the division believes that sensor positions such as those mentioned on page 4, paragraph 3 can well be distinguished, this is not the case for body parts such as the ring finger and the index finger, due to their like anatomy, e.g. like range of movements and like dimensions.

See also Guidelines F-III 1.

Even though claim 2 lists a set of body parts, the incorporation of the additional features of claim 2 into claims 1 and 16 would probably not overcome the objections, since the list in claim 2 is open ("includes") and thus is not limited to the particular body parts listed.

1.2 The subject-matter of the main, 1st and 2nd auxiliary requests is even broader and thus also does not fulfill the requirements of Art. 83 and 84.

The main and 2nd auxiliary requests even do not relate to accelerometers. Applicant has not provided an embodiment in which e.g. temperature can be used to determine the position of the sensor on a particular body part.

2 The following documents were found in a search of the state of the art in accordance with Article 54(3) EPC. Copies of the documents are annexed to the communication and the numbering will be adhered to in the rest of the procedure:

D4 US 2006/112754 A1 (YAMAMOTO HIROSHI [JP] ET AL) 1 June 2006 (2006-06-01)

D5 WO 2004/091400 A1 (MATSUSHITA ELECTRIC IND CO LTD) 28 October 2004 (2004-10-28)

While D5 is state of the art under Art. 54(2), the division refers to D4, which is the English translation of D5 written in Japanese.

3 Lack of Novelty

3.1 3rd auxiliary request

The present application does not meet the requirements of Article 52(1) EPC because the subject-matter of claims 1 and 16 is not new within the meaning of Article 54(1) and (2) EPC.

D4 discloses

A measuring system (figures 6 and 7) comprising
- an accelerometer (11) arranged to be attached at a plurality of body parts of a subject for obtaining a measured value representing a physical or a physiological quantity of the subject at a body part to which the accelerometer is attached (paragraphs 44 and 70),
- means (12) for deriving a subject-related value from the measured value in dependence on which body part the accelerometer is attached to (paragraph 71)
- means (32; paragraph 70) for determining on which body part of the subject

the accelerometer is attached to by analyzing on the basis of a predefined set of rules related to the measured value a signal from the accelerometer for features that are position dependent.

The subject-matter of claim 1 is thus not novel over D5.

3.2 The subject-matter of the main, 1st and 2nd auxiliary requests is even broader and thus also does not fulfill the requirement of novelty.

4 It is not at present apparent which part of the application could serve as a basis for a new, allowable claim. Even if the claims were amended to fulfill the requirements of Arts. 83 and 84, they would probably still lack an inventive step (Art. 52(1), 56). The subject-matter of the claims and the description appears to be a normal design option once the subject-matter of claim 1 of the 3rd auxiliary request lacks novelty.

Amended claims may not relate to unsearched subject-matter which does not combine with the originally claimed invention to form a single general inventive concept (Rule 137(5), 164(2) EPC, G2/92).

5 The applicant is requested to bring the description, in particular the statement of invention, into conformity with amended claims, Rule 42(1)(c) and Art. 84 EPC. To meet the requirements of Rule 42(1)(b) EPC, the document D5 needs to be identified in the description and the relevant background art disclosed therein should be briefly discussed.

Europäisches Patentamt
European Patent Office
Office européen des brevets

European Patent Office
80298 MUNICH
GERMANY

Questions about this communication ?
Contact Customer Services at www.epo.org/contact

Verweij, Petronella Danielle
Philips Intellectual Property & Standards
P.O. Box 220
5600 AE Eindhoven
PAYS-BAS

Date
30-06-2014

Reference	Application No./Patent No.
2005P02656WE	06832085.2 - 1506 / 1962670

Applicant/Proprietor
Koninklijke Philips N.V.

Summons to attend oral proceedings pursuant to Rule 115(1) EPC

You are hereby summoned to attend oral proceedings arranged in connection with the above-mentioned European patent application.

The matters to be discussed are set out in the communication accompanying this summons (EPO Form 2906).

The oral proceedings, which will not be public, will take place before the Examining Division

on 18.03.15 at 09.00 hrs, EPO Dienststelle
Berlin, Gitschiner Str. 103, D-10969 Berlin

No changes to the date of the oral proceedings can be made, except on serious grounds (see OJ EPO 1/2009, 68). If you do not appear as summoned, the oral proceedings may continue without you (R. 115(2) EPC, see also OJ EPO 10/2008, 471).

Your attention is drawn to Rule 4 EPC, regarding the language of the oral proceedings, and to the Special edition No. 3 OJ EPO 2007, L.1., concerning the filing of authorisations for company employees and lawyers acting as representatives before the EPO.

The final date for making written submissions and/or amendments (R. 116 EPC) is 18.02.15.

The actual room number as well as the waiting room numbers will be given to you by the porter in the foyer at the EPO.

1st Examiner:	2nd Examiner:	Chairman:
Clevorn J	Pohjamo T	Jonsson P

For the Examining Division

Annexes:
Confirmation of receipt (Form 2936)
Communication (EPO Form 2906)

Registered letter with advice of delivery
EPO Form 2008 10.13 [ORAL03=B000] (25/06/14)

to EPO postal service: 25.06.14

Europäisches Patentamt
European Patent Office
Office européen des brevets

European Patent Office
10958 BERLIN
GERMANY
Tel: +49 30 2590 10
Fax: +49 30 2590 1840

Application No.: 06 832 085.2

Preparation for oral proceedings - Instructions to Support Service

Oral proceedings are to be held in connection with the above patent application

1. The matters to be discussed are set out in the annex (Form 2906)

2. Dispatch the summons using Form 2008/2310 and Form 2906 for the parties to attend on:

Day 18.03.2015 Time 09:00

ROOMS

Room booked

ORAL 01, 02, 03 and 05 coded

Date Initials

2.1 Parties' submissions in preparation for the oral proceedings, if any, should be made no later than

1 month(s)

before the date of the oral proceedings
(transfer to Form 2008.1 / 2310.1)

2.2 Encode ORAL(04) coded

Date Initials

2.3 Dispatch Form 2008.7 / 2310.7 to division

Date Initials

3. ☐ Arrange for the following special equipment to be provided in the conference room:

Date Initials

25/6/14

Europäisches Patentamt
European Patent Office
Office européen des brevets

European Patent Office
10958 BERLIN
GERMANY
Tel: +49 30 2590 10
Fax: +49 30 2590 1840

4. Request language service to provide simultaneous interpretation facilities as necessary

....
Date Initials

5. Return the dossier to primary examiner with Form 2041 (15 days before the oral proceedings)

....
Date Initials

6. Check that summons has been received (Form 2936 / advice of delivery)

7. 15 days before the oral proceedings:
- dispatch the dossier to the primary examiner.

23.6.2014
Date

Jonsson, P.O. Chairman	Pohjamo, Terhi 2nd examiner	Clevorn, Jens 1st examiner	Legal member

Enclosure(s):

PHILIPS

European Patent Office
Attn. Ms Claudia Weber
Dir. 523 - Legal Division - CVU
Patent Administration
80298 Munich
Germany

Philips Intellectual Property & Standards

P.O. Box 220
5600 AE Eindhoven
The Netherland

Tel: +31 40 27 40607
Fax: +31 40 27 43489

EPO - Munich
11
14. Nov. 2013

Ref: VERW
Date: 7 Nov. 2013

Re: Request to record changes of Philips' references

Dear Ms. Weber,

As discussed by phone and following my e-mail dated 30 October 2013 we herewith kindly request you to change the Philips' reference codes as indicated in the enclosed document.

Please note that the old reference numbers indicated in the first column have the prefix "PH" in your system for most cases.

Please contact me in case of any questions.

Yours faithfully,

P. D. Verweij

Authorized Representative of
KONINKLIJKE PHILIPS N.V.

Europäisches Patentamt
European Patent Office
Office européen des brevets

European Patent Office
10958 BERLIN
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Verweij, Petronella Danielle
Philips Intellectual Property & Standards
P.O. Box 220
5600 AE Eindhoven
PAYS-BAS

For any questions about this communication:
Tel.:+31 (0)70 340 45 00

Date
22.08.13

Reference	Application No./Patent No.
PH003603EP2	06832085.2 - 1506 / 1962670

Applicant/Proprietor
Koninklijke Philips N.V.

Communication

concerning the registration of amendments relating to

☐ a transfer (R. 22 and 85 EPC)

☑ entries pertaining to the applicant / the proprietor (R. 143(1)(f) EPC)

As requested, the entries pertaining to the applicant of the above-mentioned European patent application / to the proprietor of the above-mentioned European patent have been amended to the following:

AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Koninklijke Philips N.V.
High Tech Campus 5
5656 AE Eindhoven/NL

The registration of the changes has taken effect on 14.08.13.

In the case of a published application / a patent, the change will be recorded in the Register of European Patents and published in the European Patent Bulletin (Section I.12 / II.12).

Your attention is drawn to the fact that, in the case of the registration of a transfer, any automatic debit order only ceases to be effective from the date of its express revocation (cf. point 14(c) of the Arrangements for the automatic debiting procedure, Supplement to OJ EPO 3/2009).

For the Examining Division

Europäisches Patentamt • European Patent Office • Office européen des brevets

Client Data Registration
Tel.: +49 (0)89 2399 2780

MEISSNER BOLTE

Meissner Bolte & Partner GbR · Postfach/P.O. Box 860624 · D-81633 München

Europäisches Patentamt
Herrn Bihl
Abteilung CDR

80298 München

Telefax Nr. 089 23994465

Patentanwälte
European Patent Attorneys
European Trademark Attorneys
European Design Attorneys
Rechtsanwälte
Lawyers

Kanzlei | Office München
Meissner Bolte & Partner GbR
Widenmayerstraße 47
D-80538 München | Germany
Tel: +49-(0)89-212186 0
Fax: +49-(0)89-212186 70
E-Mail: mail@mbp.de
www.mbp.de

Datum Date	Ihr Zeichen Your ref.	Unser Zeichen Our ref.	Ihr Ansprechpartner Your contact
14. August 2013 ZE/wr/sl		M/IPAN-REC	Dr. Stefan Zech

Namens- und Adressänderung
Koninklijke Philips Electronics N.V.
Vollmacht

Sehr geehrter Herr Bihl,

wir beziehen uns auf unseren Antrag auf Namens- und Adressänderung vom 13. August 2013 und übermitteln Ihnen beigefügt die vom Anmelder unterzeichnete Vollmacht.

Für Rückfragen stehen wir Ihnen gerne zur Verfügung.

Mit freundlichen Grüßen

Dr. Stefan Zech, LL.M.
Patentanwalt

Anlage:
Vollmacht

Vollmacht[1] Authorisation[1] Pouvoir[1]

Bitte vor dem Ausfüllen des Formblatts Rückseite beachten. / Please read the notes overleaf before completing the form. / Veuillez lire les remarques au verso avant de remplir le formulaire

Zeichen des Vertreters (der Vertreter) / Representative's reference / Référence du (des) mandataire(s) (max. 15 Positionen / max. 15 spaces / 15 caractères au maximum)

Nr. der Anmeldung (des Patents) / Application/Patent No. / N° de la demande (du brevet)

Ich (Wir) / I (We) / Je (Nous)[2]

Koninklijke Philips N.V.
High Tech Campus 5
5656 AE Eindhoven
The Netherlands

bevollmächtige(n) hiermit / do hereby authorise / autorise (autorisons) par la présente[3]

Meissner Bolte & Partner GbR
Widenmayerstr. 48, D-80538 München
Tel. (089) 2121860, Fax (089) 21218670
Postf./P.O.B. 86 06 24, D-81633 München

Dr. Eugen Popp, Wolf E. Sajda, Dr. Johannes Bohnenberger, Volkmar Kruspig, Kay Rupprecht, Dr. Stefan M. Zech, Dr. Ekkehard Heinze, Jochen Kilchert, Dr. Ole Trinks, Dr. Andrew Parker, Dr. H. Hagemann, Dr. Stephan Held, Dr. Felix Letzelter, Gernot H. Schröer, Markus Schlögl, Brigitte Kaminsky, Janet Bray, Erich Bolte, Friedrich Möller, Karsten Heiland, Martin Aulich, Nils Ellberg

☐ Weitere Vertreter sind auf einem gesonderten Blatt angegeben. / Additional representatives indicated on supplementary sheet. / D'autres mandataires sont mentionnés sur une feuille supplémentaire.

mich (uns) zu vertreten als / to represent me (us) as / à me (nous) représenter en tant que

☐ Anmelder oder Patentinhaber, / applicant(s) or patent proprietor(s), / demandeur(s) ou titulaire(s) du brevet,

☐ Einsprechenden (Einsprechende), / opponent(s), / opposant(s),

für mich (uns) zu handeln in den durch das Europäische Patentübereinkommen geschaffenen Verfahren in der (den) folgenden europäischen Patentanmeldung(en) oder dem (den) folgenden europäischen Patent(en)[4] und Zahlungen für mich (uns) in Empfang zu nehmen: / to act for me (us) in all proceedings established by the European Patent Convention concerning the following European patent application(s) or patent(s)[4] and to receive payments on my (our) behalf: / à agir en mon (notre) nom dans toute procédure instituée par la Convention sur le brevet européen et concernant la (les) demande(s) de brevet ou le (les) brevet(s) européen(s)[4] suivant(s) et à recevoir des paiements en mon (notre) nom:

The authorisation is limited to the recordal of change of name and address.

Weitere Anmeldungen oder Patente sind auf einem gesonderten Blatt angegeben. / Additional applications or patents indicated on supplementary sheet. / D'autres demandes ou brevets sont mentionnés sur une feuille supplémentaire.

☐ Die Vollmacht gilt auch für Verfahren nach dem Vertrag über die internationale Zusammenarbeit auf dem Gebiet des Patentwesens. / This authorisation shall also apply to the same extent to any proceedings established by the Patent Cooperation Treaty. / Ce pouvoir s'applique également à toute procédure instituée par le Traité de coopération en matière de brevets.

☐ Diese Vollmacht gilt auch für eventuelle europäische Teilanmeldungen. / This authorisation also covers any European divisional applications. / Le présent pouvoir vaut également pour les demandes divisionnaires européennes qui pourraient être déposées.

☐ Untervollmacht kann erteilt werden. / Sub-authorisation may be given. / Le pouvoir pourra être délégué.

☐ Ich (Wir) widerrufe(n) hiermit frühere Vollmachten in Sachen der obenbezeichneten Anmeldung(en) oder des obenbezeichneten Patents (der obenbezeichneten Patente)[5]. / I (We) hereby revoke all previous authorisations in respect of the above application(s) or patent(s)[5]. / Je révoque (Nous révoquons) par la présente tout pouvoir antérieur, donné pour la (les) demande(s) ou le (les) brevet(s) mentionné(s) ci-dessus[5].

Ort/Place/Lieu: Eindhoven, The Netherlands Datum/Date: August 14, 2013

Unterschrift(en) / Signature(s)[6]

P.D. Verweij, Profemaal Representative
Authorized Representative

Erfüllungsort für alle Ansprüche aus dem der Vollmacht zugrunde liegenden Rechtsverhältnis und Gerichtsstand ist der Ort der Kanzlei des Patentanwalts (der Patentanwälte). / The place of settlement and the court for all claims arising out of the legal relationship existing by virtue of the Power of Attorney are at the location where the office of the Patent Attorney(s) is situated. / Pour toute contestation concernant le rapport juridique du pouvoir de droit, seul le tribunal du lieu où est basé le cabinet de l'agent de brevet (ou des agents de brevet) sera compétent.

Das Formblatt muß vom (von den) Vollmachtgeber(n) (bei juristischen Personen vom Unterschriftsberechtigten) eigenhändig unterzeichnet sein. Nach der Unterschrift bitte den (die) Namen des (der) Unterzeichneten in Druckschrift wiederholen (bei juristischen Personen die Stellung des Unterschriftsberechtigten innerhalb der Gesellschaft angeben). / The form must bear the personal signature(s) of the authorisor(s) (in the case of legal persons, that of the officer empowered to sign). After the signature, please print the name(s) of the signatory(ies) adding, in the case of legal persons, his (their) position within the company. / Le formulaire doit être signé de la propre main du (des) mandant(s) (dans le cas de personnes morales, de la personne ayant qualité pour signer). Veuillez ajouter en caractères d'imprimerie, après la signature, le (les) nom(s) du (des) signataire(s) en mentionnant, dans le cas de personnes morales, ses (leurs) fonctions au sein de la société.

bitte wenden / P.T.O. / T.S.V.P.

MEISSNER BOLTE

Meissner Bolte & Partner GbR · Postfach/P.O. Box 860624 · D-81633 München

Europäisches Patentamt
Herrn Bihl
Abteilung CDR

80298 München

Telefax Nr. 089 23994465

Patentanwälte
European Patent Attorneys
European Trademark Attorneys
European Design Attorneys
Rechtsanwälte
Lawyers

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Widenmayerstraße 47
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Tel: +49-(0) 89-21 21 86 0
Fax: +49-(0) 89-21 21 86 70
E-Mail: mail@mbp.de
www.mbp.de

Datum Date	Ihr Zeichen Your ref.	Unser Zeichen Our ref.	Ihr Ansprechpartner Your contact
13. August 2013 ZE/wr/sl		M/IPAN-REC	Dr. Stefan Zech

Namens- und Adressänderung
Koninklijke Philips Electronics N.V.

ip_law@mbp.®

Sehr geehrter Herr Bihl,

wir sind beauftragt, für die Koninklijke Philips N.V. die Namens- und Adressänderung beim Europäischen Patentamt durchzuführen und wir dürfen dabei Bezug nehmen auf Ihr Telefonat mit Herrn Anton Wallner bezüglich der Namens- und Adressänderung des Anmelders:

Koninklijke Philips Electronics N.V.
Groenewoudseweg 1
5621 BA Eindhoven
The Netherlands

in

Koninklijke Philips N.V.
High Tech Campus 5
5656 AE Eindhoven
The Netherlands

Wir dürfen Sie bitten, den Namen und die Adresse für alle relevanten Europäischen Patentanmeldungen zu ändern und die Änderung auch für neue regionale Phasen in EP, die aus PCT kommen, vorzunehmen.

Desweiteren dürfen wir Sie bitten, die Änderung auch für die eingetragenen Vertreter, sofern diese auf die Koninklijke Philips Electronics N.V. eingetragen sind, zu ändern.

MEISSNER BOLTE

Gemäß Absprache sind Einzelbestätigungen für die Änderungen nicht notwendig, eine Gesamtbestätigung (Liste) über die durchgeführten Änderungen nehmen wir dankend entgegen. Diese kann auch per email an

wr@mbp.de

gesandt werden.

Für Rückfragen stehen wir Ihnen gerne zur Verfügung.

Mit freundlichen Grüßen

Dr. Stefan Zech, LL.M.
Patentanwalt

Anlage:
Umschreibebestätigung (holländisch / englisch)

ip_law@mbp.®

TO WHOM IT MAY CONCERN

This is to certify that **Koninklijke Philips Electronics N.V.** changed its name into **Koninklijke Philips N.V.** on 15th May 2013.

Koninklijke Philips N.V. is a public limited liability company, incorporated on 11th September 1912 under the laws of the Kingdom of The Netherlands, having its seat at Eindhoven, High Tech Campus 5 and is registered in the Trade Register at Eindhoven under number 17001910.

SHARE CAPITAL

Authorised capital:
EUR 800,000,000.-
Issued and paid-up:
EUR 191,426,592.40

BOARD OF MANAGEMENT

F.A. van Houten
P.A.J. Nota
R.H. Wirahadiraksa

Two members of the Board of Management may jointly represent the company at law and otherwise.

AAN DE BELANGHEBBENDE

Hierbij verklaren wij dat **Koninklijke Philips Electronics N.V.** op 15 mei 2013 haar naam heeft gewijzigd in **Koninklijke Philips N.V.**

Koninklijke Philips N.V. is een naamloze vennootschap, op 11 september 1912 voor onbepaalde tijd opgericht volgens Nederlands recht, met haar zetel in Eindhoven, High Tech Campus 5 en ingeschreven in het Handelsregister in Eindhoven onder nummer 17001910.

AANDELENKAPITAAL:

Maatschappelijk kapitaal:
EUR 800.000.000,-
Geplaatst en gestort:
EUR 191.426.592,40

RAAD VAN BESTUUR:

F.A. van Houten
R.H. Wirahadiraksa
P.A.J. Nota

Twee leden van de Raad van Bestuur gezamenlijk vertegenwoordigen de vennootschap in en buiten rechte.

Eindhoven, 16 mei 2013

Kamer van Koophandel Brabant

Jaap van de Vijfeijken
Administratief medewerker
Afdeling bedrijvenregister

Europäisches Patentamt
European Patent Office
Office européen des brevets

European Patent Office
10958 BERLIN
GERMANY
Tel. +49 (0)30 25901 - 0
Fax +49 (0)30 25901 - 840

Verweij, Petronella Danielle
Philips Intellectual Property & Standards
P.O. Box 220
5600 AE Eindhoven
PAYS-BAS

For any questions about this communication:
Tel.:+31 (0)70 340 45 00

Date
18.07.12

Reference	Application No./Patent No.
PH003603EP2	06832085.2 - 1526 / 1962670

Applicant/Proprietor
Koninklijke Philips Electronics N.V.

Communication of amended entries concerning the representative (R. 143(1)(h) EPC)

As requested, for the above-mentioned European patent application / European patent the entries concerning the representative have been amended as follows:

Verweij, Petronella Danielle
Philips Intellectual Property & Standards
P.O. Box 220
5600 AE Eindhoven
NL

The amendment will be recorded in the Register of European Patents.

For the Examining Division

Europäisches Patentamt • European Patent Office • Office européen des brevets

Client Data Registration
Tel.: +49 (0)89 2399 2780

Proform of Check transfer at EPO
e.g. 0090672.3
0092642.2

PHILIPS

Philips Intellectual Property & Standards

P.O. Box 220, 5600 AE Eindhoven, The Netherlands

European Patent Office
Client Data Registration

For attention of: mr. Eric Bihl

By FAX: +49 89 2399 4465

Subject: Case transfer
Groenendaal / Schouten

Date: 2012-06-26

Dear mr. Bihl,

We hereby request transfer of our European patent applications in name of the following representatives, formerly with Philips Intellectual Property & Standards (IP&S):

Groenendaal, Antonius
Schouten, Marcus

to the new representative **Verweij, Petronella**, also with Philips IP&S.

Please make sure only cases in name of mr. Schouten at Philips IP&S will be transferred, and that the representative for cases in name of mr. Schouten at NXP B.V. remain unchanged.

Thank you for your assistance,
Kind regards,

Daniël Martijn Damen
Professional Representative

Europäisches Patentamt
European Patent Office
Office européen des brevets

Acknowledgement of receipt

We hereby acknowledge receipt of the following subsequently filed document(s):

Submission number	1047407
Application number	EP06832085.2
Date of receipt	22 December 2010
Receiving Office	European Patent Office, The Hague
Your reference	PH003603EP2
Applicant	All applicants as on file

Documents submitted

package-data.xml

epf1038.pdf (1 p.)

DESCPAMD-1.pdf\PH003603EP2 Amended pages 3, 6, 6a and 8.pdf (4 p.)

CLMSPAMD-2.pdf\PH003603 EP2 claims main req. clean (22.12).pdf (3 p.)

CLMSPAMD-4.pdf\PH003603 EP2 claims 1st aux req. clean (22.12).pdf (3 p.)

CLMSPAMD-6.pdf\PH003603 EP2 claims 2nd aux req. clean (22.12).pdf (3 p.)

CLMSPAMD-8.pdf\PH003603 EP2 claims 3rd aux req. clean (22.12).pdf (3 p.)

ep-sfd-request.xml

EXRE3-1.pdf\PH003603 EP2 brf EPO (22.12).pdf (9 p.)

CLMSPAMD-1.pdf\PH003603 EP2 claims main req. marked-up (22.12).pdf (3 p.)

CLMSPAMD-3.pdf\PH003603 EP2 claims 1st aux req. marked-up (22.12).pdf (3 p.)

CLMSPAMD-5.pdf\PH003603 EP2 claims 2nd aux req. marked-up (22.12).pdf (3 p.)

CLMSPAMD-7.pdf\PH003603 EP2 claims 3rd aux req. marked-up (22.12).pdf (4 p.)

Submitted by	CN=S. Cumpson 17365,O=Philips IP&S,C=NL

Method of submission	Online
Date and time receipt generated	22 December 2010, 09:41 (CET)
Message Digest	37:A3:1C:40:25:63:E8:A1:23:13:30:B6:69:36:FA:42:F5:34:41:A3

Correction by the EPO of errors in debit instructions filed by eOLF

Errors in debit instructions filed by eOLF that are caused by the editing of Form 1038E entries or the continued use of outdated software (all forms) may be corrected automatically by the EPO, leaving the payment date unchanged (see decision T 152/82, OJ EPO 1984, 301 and point 6.3 ff ADA, Supplement to OJ EPO 10/2007).

/European Patent Office/

AMENDED SET OF CLAIMS:

1. A measuring system (1) comprising

- an ~~accelerometer~~~~sensor~~ (6) arranged to be attached at ~~one of~~ a plurality of ~~positions on~~body parts of a subject for obtaining a measured value representing a physical or a physiological quantity of the subject at a body part to which the accelerometer is attached,

- means for deriving a subject-related value from the measured value in dependence on ~~the position of~~which body part the ~~sensor~~accelerometer is attached to~~on the subject~~,

characterized in the measuring system further comprising

- means for determining ~~the position of~~on which body part of the subject the ~~sensor~~accelerometer is attached to~~on the subject~~ by analyzing on the basis of a predefined set of rules related to the measured value a signal from the ~~sensor~~accelerometer for features that are position dependent.

2. The measuring system (1) according to claim 1, wherein the plurality of ~~positions~~ body parts includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head.

3. The measuring system (1) according to claim 1, wherein the derived value comprises an activity parameter of the subject,
the activity parameter comprising energy expenditure.

4. The measuring system (1) according to claim 1, wherein the activity parameter represents a degree of activity of the body part the ~~sensor~~accelerometer is attached to.

5. The measuring system (1) according to claim 1, wherein the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration.

6. The measuring system (1) according to claim 1, further comprising means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on ~~the position of~~which body part of the subject the ~~sensor~~accelerometer ~~on the subject~~ is attached to, and the ~~sensor~~accelerometer is arranged for generating a further measured value for each quantity in the selected subset.

7. The measuring system (1) according to claim 1, further comprising

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

8. The measuring system (1) according to claim 1, wherein the means for determining to which body part the accelerometer is attached is arranged for performing the determining in dependence on the measured value.

9~~8~~. The measuring system (1) according to claim ~~1~~8, further comprising means for obtaining from the ~~sensor~~accelerometer (6) a plurality of measured values measured during a time interval, and wherein the means for determining ~~the position of~~to which body part the ~~sensor~~accelerometer is attached~~on the subject~~ is arranged for performing the determining in dependence on the measured values measured during the time interval.

10~~9~~. The measuring system (1) according to claim ~~1 or~~ 8 or 9, wherein the means for determining to which body part ~~the position of~~ the ~~sensor~~accelerometer (6) is attached~~on the subject~~ is arranged for performing the determining on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively.

11~~10~~. The measuring system (1) according to claim ~~8~~9, wherein the means for determining to which body part~~the position of~~ the ~~sensor~~accelerometer (6) is attached~~on the subject~~ comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval.

~~11~~12. The measuring system (1) according to claim ~~1 or 8~~ or 9, further comprising means for determining that the user is performing a standardized activity, and wherein the means for determining to which body part ~~the position of~~ the ~~sensor~~accelerometer is attached~~on the subject~~ is arranged for using at least one measured value obtained from the ~~sensor~~accelerometer (6), the measured value relating to a time the user is performing the standardized activity.

~~12~~13. The measuring system (1) according to claim 1, further comprising a user interface for receiving input from a user related to ~~the position of~~which body part of the subject the ~~sensor~~accelerometer is attached to~~on the subject~~.

~~13~~14. The measuring system (1) according to claim 1, further comprising

- means for establishing that the subject is performing a predetermined activity,

- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,

- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and

- means for providing feedback in dependence on the similarity measure.

~~14~~15. A system for determining the calorie balance of a subject, the system comprising the measuring system (1) according to claim 4, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure.

~~15~~16. A method of estimating a derived value relating to a subject, the method comprising

- obtaining at least one measured value from an ~~sensor~~accelerometer (6) attached to a body part of the subject, the measured value representing a physical or a physiological quantity of the subject at the body part to which the sensor is attached, and

- determining ~~the position of~~which body part the ~~sensor~~accelerometer is attached to~~on the subject by analyzing a signal from the sensor for features that are position dependent~~, and

- deriving the subject-related value from the measured value also in dependence on ~~the position of the sensor on the subject~~which body part the accelerometer is attached to.

AMENDED SET OF CLAIMS:

1. A measuring system (1) comprising

- an ~~sensor~~ accelerometer (6) arranged to be attached at ~~one of~~ a plurality of ~~positions on~~body parts of a subject for obtaining a measured value representing a physical or a physiological quantity of the subject at a body part to which the accelerometer is attached,

- means for deriving a subject-related value from the measured value in dependence on ~~the position of~~which body part the ~~sensor~~accelerometer is attached to~~on the subject~~,

characterized in the measuring system further comprising

- means for determining ~~the position of~~on which body part of the subject the ~~sensor~~accelerometer is attached to~~on the subject by analyzing a signal from the sensor for features that are position dependent~~.

2. The measuring system (1) according to claim 1, wherein the plurality of ~~positions~~ body parts includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head.

3. The measuring system (1) according to claim 1, wherein the derived value comprises an activity parameter of the subject,
the activity parameter comprising energy expenditure.

4. The measuring system (1) according to claim 1, wherein the activity parameter represents a degree of activity of the body part the ~~sensor~~accelerometer is attached to.

5. The measuring system (1) according to claim 1, wherein the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration.

6. The measuring system (1) according to claim 1, further comprising means for selecting a subset of a predefined set of further physical and/or physiological quantities of the

subject in dependence on ~~the position of~~which body part of the subject the ~~sensor~~accelerometer ~~on the subject~~ is attached to, and the ~~sensor~~accelerometer is arranged for generating a further measured value for each quantity in the selected subset.

7. The measuring system (1) according to claim 1, further comprising

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

8. The measuring system (1) according to claim 1, wherein the means for determining to which body part the accelerometer is attached is arranged for performing the determining in dependence on the measured value.

~~9~~8. The measuring system (1) according to claim ~~1~~8, further comprising means for obtaining from the ~~sensor~~accelerometer (6) a plurality of measured values measured during a time interval, and wherein the means for determining ~~the position of~~to which body part the ~~sensor~~accelerometer is attached~~on the subject~~ is arranged for performing the determining in dependence on the measured values measured during the time interval.

~~9~~10. The measuring system (1) according to claim ~~1 or 8~~ or 9, wherein the means for determining to which body part ~~the position of~~ the ~~sensor~~accelerometer (6) is attached~~on the subject~~ is arranged for performing the determining on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively.

~~10~~11. The measuring system (1) according to claim ~~8~~9, wherein the means for determining to which body part~~the position of~~ the ~~sensor~~accelerometer (6) is attached~~on the subject~~ comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval.

~~11~~12. The measuring system (1) according to claim ~~1 or 8~~ or 9, further comprising means for determining that the user is performing a standardized activity, and wherein the means for determining to which body part ~~the position of~~ the ~~sensor~~accelerometer is

attachedon the subject is arranged for using at least one measured value obtained from the sensoraccelerometer (6), the measured value relating to a time the user is performing the standardized activity.

~~12~~13. The measuring system (1) according to claim 1, further comprising a user interface for receiving input from a user related to the position ofwhich body part of the subject the sensoraccelerometer is attached toon the subject.

~~13~~14. The measuring system (1) according to claim 1, further comprising

- means for establishing that the subject is performing a predetermined activity,

- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,

- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and

- means for providing feedback in dependence on the similarity measure.

~~14~~15. A system for determining the calorie balance of a subject, the system comprising the measuring system (1) according to claim 4, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure.

~~15~~16. A method of estimating a derived value relating to a subject, the method comprising

- obtaining at least one measured value from an sensoraccelerometer (6) attached to a body part of the subject, the measured value representing a physical or a physiological quantity of the subject at the body part to which the accelerometer is attached, and

- determining the position ofwhich body part the sensoraccelerometer is attached toon the subject by analyzing a signal from the sensor for features that are position dependent, and

- deriving the subject-related value from the measured value also in dependence on the position of the sensor on the subjectwhich body part the accelerometer is attached to.

AMENDED SET OF CLAIMS:

1. A measuring system (1) comprising

- a sensor (6) arranged to be attached at ~~one of~~ a plurality of ~~positions on~~body parts of a subject for obtaining a measured value representing a physical or a physiological quantity of the subject at a body part to which the sensor is attached,

- means for deriving a subject-related value from the measured value in dependence on ~~the position of~~which body part the sensor is attached to~~on the subject~~, characterized in the measuring system further comprising

- means for determining ~~the position of~~on which body part of the subject the sensor is attached to~~on the subject by analyzing a signal from the sensor for features that are position dependent~~.

2. The measuring system (1) according to claim 1, wherein the plurality of ~~positions~~ body parts includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head.

3. The measuring system (1) according to claim 1, wherein the derived value comprises an activity parameter of the subject,
the activity parameter comprising energy expenditure.

4. The measuring system (1) according to claim 1, wherein the activity parameter represents a degree of activity of the body part the sensor is attached to.

5. The measuring system (1) according to claim 1, wherein the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration.

6. The measuring system (1) according to claim 1, further comprising means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on ~~the position of~~which body part of the subject the sensor ~~on the~~

~~subject~~ is attached to, and the sensor is arranged for generating a further measured value for each quantity in the selected subset.

7. The measuring system (1) according to claim 1, further comprising

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

8. The measuring system (1) according to claim 1, wherein the means for determining to which body part the sensor is attached is arranged for performing the determining in dependence on the measured value.

~~9~~8. The measuring system (1) according to claim ~~1~~8, further comprising means for obtaining from the sensor (6) a plurality of measured values measured during a time interval, and wherein the means for determining ~~the position of~~to which body part the sensor is attached~~on the subject~~ is arranged for performing the determining in dependence on the measured values measured during the time interval.

~~9~~10. The measuring system (1) according to claim ~~1 or 8~~ or 9, wherein the means for determining to which body part ~~the position of~~ the sensor (6) is attached~~on the subject~~ is arranged for performing the determining on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively.

~~10~~11. The measuring system (1) according to claim ~~8~~9, wherein the means for determining to which body part~~the position of~~ the sensor (6) is attached~~on the subject~~ comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval.

~~11~~12. The measuring system (1) according to claim ~~1 or 8~~ or 9, further comprising means for determining that the user is performing a standardized activity, and wherein the means for determining to which body part~~the position of~~ the sensor is attached~~on the subject~~ is arranged for using at least one measured value obtained from the sensor (6), the measured value relating to a time the user is performing the standardized activity.

~~12~~13. The measuring system (1) according to claim 1, further comprising a user interface for receiving input from a user related to ~~the position of~~which body part of the subject the sensor is attached to~~on the subject~~.

~~13~~14. The measuring system (1) according to claim 1, further comprising

- means for establishing that the subject is performing a predetermined activity,

- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,

- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and

- means for providing feedback in dependence on the similarity measure.

~~14~~15. A system for determining the calorie balance of a subject, the system comprising the measuring system (1) according to claim 4, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure.

~~15~~16. A method of estimating a derived value relating to a subject, the method comprising

- obtaining at least one measured value from a sensor (6) attached to a body part of the subject, the measured value representing a physical or a physiological quantity of the subject at the body part to which the sensor is attached, and

- determining ~~the position of~~which body part the sensor is attached to~~on the subject by analyzing a signal from the sensor for features that are position dependent~~, and

- deriving the subject-related value from the measured value also in dependence on ~~the position of the sensor on the subject~~which body part the sensor is attached to.

AMENDED SET OF CLAIMS:

1. A measuring system (1) comprising

- a sensor (6) arranged to be attached at ~~one of~~ a plurality of ~~positions on~~ body parts of a subject for obtaining a measured value representing a physical or a physiological quantity of the subject at a body part to which the sensor is attached,

- means for deriving a subject-related value from the measured value in dependence on ~~the position of~~ which body part the sensor is attached to ~~on the subject~~, characterized in the measuring system further comprising

- means for determining ~~the position of~~ on which body part of the subject the sensor is attached to ~~on the subject~~ by analyzing on the basis of a predefined set of rules related to the measured value a signal from the sensor for features that are position dependent.

2. The measuring system (1) according to claim 1, wherein the plurality of ~~positions~~ body parts includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head.

3. The measuring system (1) according to claim 1, wherein the derived value comprises an activity parameter of the subject,
the activity parameter comprising energy expenditure.

4. The measuring system (1) according to claim 1, wherein the activity parameter represents a degree of activity of the body part the sensor is attached to.

5. The measuring system (1) according to claim 1, wherein the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration.

6. The measuring system (1) according to claim 1, further comprising means for selecting a subset of a predefined set of further physical and/or physiological quantities of the

subject in dependence on ~~the position of~~which body part of the subject the sensor ~~on the subject~~ is attached to, and the sensor is arranged for generating a further measured value for each quantity in the selected subset.

7. The measuring system (1) according to claim 1, further comprising

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

8. The measuring system (1) according to claim 1, wherein the means for determining to which body part the sensor is attached is arranged for performing the determining in dependence on the measured value.

~~9~~8. The measuring system (1) according to claim ~~1~~8, further comprising means for obtaining from the sensor (6) a plurality of measured values measured during a time interval, and wherein the means for determining ~~the position of~~to which body part the sensor is attached~~on the subject~~ is arranged for performing the determining in dependence on the measured values measured during the time interval.

~~9~~10. The measuring system (1) according to claim ~~1 or 8~~9, wherein the means for determining to which body part ~~the position of~~ the sensor (6) is attached~~on the subject~~ is arranged for performing the determining on the basis of a predefined set of rules related to the ~~measured value or~~ measured values measured during the time interval~~, respectively~~.

~~10~~11. The measuring system (1) according to claim ~~8~~9, wherein the means for determining to which body part~~the position of~~ the sensor (6) is attached~~on the subject~~ comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval.

~~11~~12. The measuring system (1) according to claim ~~1 or 8~~ or 9, further comprising means for determining that the user is performing a standardized activity, and wherein the means for determining to which body part ~~the position of~~ the sensor is attached~~on the subject~~

is arranged for using at least one measured value obtained from the sensor (6), the measured value relating to a time the user is performing the standardized activity.

~~12~~13. The measuring system (1) according to claim 1, further comprising a user interface for receiving input from a user related to ~~the position of~~which body part of the subject the sensor is attached to~~on the subject~~.

~~13~~14. The measuring system (1) according to claim 1, further comprising

- means for establishing that the subject is performing a predetermined activity,

- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,

- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and

- means for providing feedback in dependence on the similarity measure.

~~14~~15. A system for determining the calorie balance of a subject, the system comprising the measuring system (1) according to claim 4, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure.

~~15~~16. A method of estimating a derived value relating to a subject, the method comprising

- obtaining at least one measured value from a sensor (6) attached to a body part of the subject, the measured value representing a physical or a physiological quantity of the subject at the body part to which the sensor is attached, and

- determining ~~the position of~~which body part the sensor is attached to~~on the subject~~ by analyzing on the basis of a predefined set of rules related to the measured value a signal from the sensor for features that are position dependent, and

- deriving the subject-related value from the measured value also in dependence on ~~the position of the sensor on the subject~~which body part the sensor is attached to.

AMENDED SET OF CLAIMS:

1. A measuring system (1) comprising

- a sensor (6) arranged to be attached at a plurality of body parts of a subject for obtaining a measured value representing a physical or a physiological quantity of the subject at a body part to which the sensor is attached,

- means for deriving a subject-related value from the measured value in dependence on which body part the sensor is attached to,

characterized in the measuring system further comprising

- means for determining on which body part of the subject the sensor is attached to by analyzing on the basis of a predefined set of rules related to the measured value a signal from the sensor for features that are position dependent.

2. The measuring system (1) according to claim 1, wherein the plurality of body parts includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head.

3. The measuring system (1) according to claim 1, wherein the derived value comprises an activity parameter of the subject,
the activity parameter comprising energy expenditure.

4. The measuring system (1) according to claim 1, wherein the activity parameter represents a degree of activity of the body part the sensor is attached to.

5. The measuring system (1) according to claim 1, wherein the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration.

6. The measuring system (1) according to claim 1, further comprising means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on which body part of the subject the sensor is attached to, and the

sensor is arranged for generating a further measured value for each quantity in the selected subset.

7. The measuring system (1) according to claim 1, further comprising

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

8. The measuring system (1) according to claim 1, wherein the means for determining to which body part the sensor is attached is arranged for performing the determining in dependence on the measured value.

9. The measuring system (1) according to claim 8, further comprising means for obtaining from the sensor (6) a plurality of measured values measured during a time interval, and wherein the means for determining to which body part the sensor is attached is arranged for performing the determining in dependence on the measured values measured during the time interval.

10. The measuring system (1) according to claim 9, wherein the means for determining to which body part the sensor (6) is attached is arranged for performing the determining on the basis of a predefined set of rules related to the measured values measured during the time interval.

11. The measuring system (1) according to claim 9, wherein the means for determining to which body part the sensor (6) is attached comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval.

12. The measuring system (1) according to claim 8 or 9, further comprising means for determining that the user is performing a standardized activity, and wherein the means for determining to which body part the sensor is attached is arranged for using at least one measured value obtained from the sensor (6), the measured value relating to a time the user is performing the standardized activity.

13. The measuring system (1) according to claim 1, further comprising a user interface for receiving input from a user related to which body part of the subject the sensor is attached to.

14. The measuring system (1) according to claim 1, further comprising

- means for establishing that the subject is performing a predetermined activity,

- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,

- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and

- means for providing feedback in dependence on the similarity measure.

15. A system for determining the calorie balance of a subject, the system comprising the measuring system (1) according to claim 4, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure.

16. A method of estimating a derived value relating to a subject, the method comprising

- obtaining at least one measured value from a sensor (6) attached to a body part of the subject, the measured value representing a physical or a physiological quantity of the subject at the body part to which the sensor is attached, and

- determining which body part the sensor is attached to by analyzing on the basis of a predefined set of rules related to the measured value a signal from the sensor for features that are position dependent, and

- deriving the subject-related value from the measured value also in dependence on which body part the sensor is attached to.

AMENDED SET OF CLAIMS:

1. A measuring system (1) comprising

- an accelerometer (6) arranged to be attached at a plurality of body parts of a subject for obtaining a measured value representing a physical or a physiological quantity of the subject at a body part to which the accelerometer is attached,

- means for deriving a subject-related value from the measured value in dependence on which body part the accelerometer is attached to,

characterized in the measuring system further comprising

- means for determining on which body part of the subject the accelerometer is attached to by analyzing on the basis of a predefined set of rules related to the measured value a signal from the accelerometer for features that are position dependent.

2. The measuring system (1) according to claim 1, wherein the plurality of body parts includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head.

3. The measuring system (1) according to claim 1, wherein the derived value comprises an activity parameter of the subject,
the activity parameter comprising energy expenditure.

4. The measuring system (1) according to claim 1, wherein the activity parameter represents a degree of activity of the body part the accelerometer is attached to.

5. The measuring system (1) according to claim 1, wherein the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration.

6. The measuring system (1) according to claim 1, further comprising means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on which body part of the subject the accelerometer is attached to, and

the accelerometer is arranged for generating a further measured value for each quantity in the selected subset.

7. The measuring system (1) according to claim 1, further comprising

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

8. The measuring system (1) according to claim 1, wherein the means for determining to which body part the accelerometer is attached is arranged for performing the determining in dependence on the measured value.

9. The measuring system (1) according to claim 8, further comprising means for obtaining from the accelerometer (6) a plurality of measured values measured during a time interval, and wherein the means for determining to which body part the accelerometer is attached is arranged for performing the determining in dependence on the measured values measured during the time interval.

10. The measuring system (1) according to claim 8 or 9, wherein the means for determining to which body part the accelerometer (6) is attached is arranged for performing the determining on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively.

11. The measuring system (1) according to claim 9, wherein the means for determining to which body part the accelerometer (6) is attached comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval.

12. The measuring system (1) according to claim 8 or 9, further comprising means for determining that the user is performing a standardized activity, and wherein the means for determining to which body part the accelerometer is attached is arranged for using at least one measured value obtained from the accelerometer (6), the measured value relating to a time the user is performing the standardized activity.

13. The measuring system (1) according to claim 1, further comprising a user interface for receiving input from a user related to which body part of the subject the accelerometer is attached to.

14. The measuring system (1) according to claim 1, further comprising

- means for establishing that the subject is performing a predetermined activity,

- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,

- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and

- means for providing feedback in dependence on the similarity measure.

15. A system for determining the calorie balance of a subject, the system comprising the measuring system (1) according to claim 4, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure.

16. A method of estimating a derived value relating to a subject, the method comprising

- obtaining at least one measured value from an accelerometer (6) attached to a body part of the subject, the measured value representing a physical or a physiological quantity of the subject at the body part to which the sensor is attached, and

- determining which body part the accelerometer is attached to, and

- deriving the subject-related value from the measured value also in dependence on which body part the accelerometer is attached to.

AMENDED SET OF CLAIMS:

1. A measuring system (1) comprising

- a sensor (6) arranged to be attached at a plurality of body parts of a subject for obtaining a measured value representing a physical or a physiological quantity of the subject at a body part to which the sensor is attached,

- means for deriving a subject-related value from the measured value in dependence on which body part the sensor is attached to,

characterized in the measuring system further comprising

- means for determining on which body part of the subject the sensor is attached to.

2. The measuring system (1) according to claim 1, wherein the plurality of body parts includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head.

3. The measuring system (1) according to claim 1, wherein the derived value comprises an activity parameter of the subject,
the activity parameter comprising energy expenditure.

4. The measuring system (1) according to claim 1, wherein the activity parameter represents a degree of activity of the body part the sensor is attached to.

5. The measuring system (1) according to claim 1, wherein the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration.

6. The measuring system (1) according to claim 1, further comprising means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on which body part of the subject the sensor is attached to, and the

sensor is arranged for generating a further measured value for each quantity in the selected subset.

7. The measuring system (1) according to claim 1, further comprising

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

8. The measuring system (1) according to claim 1, wherein the means for determining to which body part the sensor is attached is arranged for performing the determining in dependence on the measured value.

9. The measuring system (1) according to claim 8, further comprising means for obtaining from the sensor (6) a plurality of measured values measured during a time interval, and wherein the means for determining to which body part the sensor is attached is arranged for performing the determining in dependence on the measured values measured during the time interval.

10. The measuring system (1) according to claim 8 or 9, wherein the means for determining to which body part the sensor (6) is attached is arranged for performing the determining on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively.

11. The measuring system (1) according to claim 9, wherein the means for determining to which body part the sensor (6) is attached comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval.

12. The measuring system (1) according to claim 8 or 9, further comprising means for determining that the user is performing a standardized activity, and wherein the means for determining to which body partthe sensor is attached is arranged for using at least one measured value obtained from the sensor (6), the measured value relating to a time the user is performing the standardized activity.

13. The measuring system (1) according to claim 1, further comprising a user interface for receiving input from a user related to which body part of the subject the sensor is attached to.

14. The measuring system (1) according to claim 1, further comprising

- means for establishing that the subject is performing a predetermined activity,

- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,

- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and

- means for providing feedback in dependence on the similarity measure.

15. A system for determining the calorie balance of a subject, the system comprising the measuring system (1) according to claim 4, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure.

16. A method of estimating a derived value relating to a subject, the method comprising

- obtaining at least one measured value from a sensor (6) attached to a body part of the subject, the measured value representing a physical or a physiological quantity of the subject at the body part to which the sensor is attached, and

- determining which body part the sensor is attached to, and

- deriving the subject-related value from the measured value also in dependence on which body part the sensor is attached to.

AMENDED SET OF CLAIMS:

1. A measuring system (1) comprising

- an accelerometer (6) arranged to be attached at a plurality of body parts of a subject for obtaining a measured value representing a physical or a physiological quantity of the subject at a body part to which the accelerometer is attached,

- means for deriving a subject-related value from the measured value in dependence on which body part the accelerometer is attached to,

characterized in the measuring system further comprising

- means for determining on which body part of the subject the accelerometer is attached to.

2. The measuring system (1) according to claim 1, wherein the plurality of body parts includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head.

3. The measuring system (1) according to claim 1, wherein the derived value comprises an activity parameter of the subject,
the activity parameter comprising energy expenditure.

4. The measuring system (1) according to claim 1, wherein the activity parameter represents a degree of activity of the body part the accelerometer is attached to.

5. The measuring system (1) according to claim 1, wherein the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration.

6. The measuring system (1) according to claim 1, further comprising means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on which body part of the subject the accelerometer is attached to, and

the accelerometer is arranged for generating a further measured value for each quantity in the selected subset.

7. The measuring system (1) according to claim 1, further comprising

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

8. The measuring system (1) according to claim 1, wherein the means for determining to which body part the accelerometer is attached is arranged for performing the determining in dependence on the measured value.

9. The measuring system (1) according to claim 8, further comprising means for obtaining from the accelerometer (6) a plurality of measured values measured during a time interval, and wherein the means for determining to which body part the accelerometer is attached is arranged for performing the determining in dependence on the measured values measured during the time interval.

10. The measuring system (1) according to claim 8 or 9, wherein the means for determining to which body part the accelerometer (6) is attached is arranged for performing the determining on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively.

11. The measuring system (1) according to claim 9, wherein the means for determining to which body part the accelerometer (6) is attached comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval.

12. The measuring system (1) according to claim 8 or 9, further comprising means for determining that the user is performing a standardized activity, and wherein the means for determining to which body part the accelerometer is attached is arranged for using at least one measured value obtained from the accelerometer (6), the measured value relating to a time the user is performing the standardized activity.

13. The measuring system (1) according to claim 1, further comprising a user interface for receiving input from a user related to which body part of the subject the accelerometer is attached to.

14. The measuring system (1) according to claim 1, further comprising

- means for establishing that the subject is performing a predetermined activity,

- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,

- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and

- means for providing feedback in dependence on the similarity measure.

15. A system for determining the calorie balance of a subject, the system comprising the measuring system (1) according to claim 4, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure.

16. A method of estimating a derived value relating to a subject, the method comprising

- obtaining at least one measured value from an accelerometer (6) attached to a body part of the subject, the measured value representing a physical or a physiological quantity of the subject at the body part to which the accelerometer is attached, and

- determining which body part the accelerometer is attached to, and

- deriving the subject-related value from the measured value also in dependence on which body part the accelerometer is attached to.

When the user uses the system for the first time, he or she may designate certain movement patterns as correlating with certain activities. This will aid to calibrate the activity monitor.

Each of the described activity monitors and sensors is designed to be placed on a single position on the body. Bodily signals such as acceleration and ECG signals, are measured local to the position where the sensor is attached to the object. For example, acceleration measured by an accelerometer on the wrist includes motion of the arm, which is not detected by an accelerometer mounted on the waist.

The existing activity monitors, including for example a wrist strap or a waist belt, are often designed to be worn on one place on the body. The existing activity monitor is calibrated such that it provides accurate results if it is attached at a predefined location on the body. If the activity monitor is attached at a different location, the measured activity may be less accurate. If the activity monitor is not attached at the reference position, errors exceeding 5% in the estimation of energy expenditure may occur. This amounts to an error exceeding approximately 100 kilocalories per day.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a measuring system that yields a more accurate estimate of a parameter relating to a subject.

According to the invention, this object is achieved in that

- the sensor is arranged to be attached at ~~one of~~ a plurality of ~~positions on~~ the body part of subject,

- the measuring system further comprises means for determining ~~the position of~~ the sensor ~~on the subject by analyzing a signal from the sensor for features that are position dependent~~ on which body part of the subject is attached, and

- the means for deriving the subject-related value is arranged for deriving the subject-related value ~~also~~ in dependence on ~~the position of~~ the sensor ~~on the subject~~ which body part is attached to.

With these provisions, the accuracy of the derived value is guaranteed for any of a plurality of positions on the body. The subject may attach the sensor at any preferred position on the body, and can preferably attach it at a different position whenever he or she desires to do so.

Subjects may have different preferences where they prefer wearing the sensor, and the same subject may prefer wearing the sensor at different locations, depending on for example the location of the subject, the local weather, or the activity the subject is

compensate the measured value with respect to the nearest reference position or with respect to a weighted average of reference positions, thereby increasing the accuracy further.

Another aspect of the invention is characterized in that the means for determining the position of the sensor on the subject is arranged for determining the position in dependence on the measured value. This allows the sensor to be attached at different positions on the subject, without any additional user interaction to indicate the actual position of the device.

According to another aspect of the invention, it further comprises means for obtaining from the sensor a plurality of measured values measured during a time interval, and wherein the means for determining the position of the sensor on the subject is arranged for determining the position in dependence on the measured values measured during the time interval. This allows the position of the sensor to be determined in an especially reliable manner.

According to another aspect of the invention, the means for determining the position of the sensor on the subject is arranged for determining the position on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively. A set of rules, preferably part of a rule-based system, possibly making use of fuzzy logic, is particularly suited for determining the position of the sensor.

According to another aspect of the invention, the means for determining the position of the sensor on the subject comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval. A pattern recognition means is especially favorable to achieve a high reliability in establishing the position of the sensor on the subject.

According to an aspect of the invention, it further comprises means for determining that the user is performing a standardized activity, and the means for determining the position of the sensor on the subject is arranged for using at least one measured value obtained from the sensor, the measured value relating to a time the user is performing the standardized activity. This allows the activity monitor to determine the position of the device on the body with greater certainty. Preferably, the standardized activity has a repetition pattern with a cycle time of, for example, 1 to 2 seconds and the standardized activity is performed for at least five cycles.

According to another aspect of the invention, the means for establishing that the user is performing a standardized activity is arranged for establishing the activity in dependence on at least one measured value. This increases the accuracy and reduces the

amount of required user interaction.

Another aspect of the invention further comprises a user interface for receiving input from a user for indicating when the subject is performing the standardized activity. This allows a very economical implementation of the activity monitor.

value is arranged for combining the respective obtained measured values in order to increase the accuracy of the derived value. Advantageously, the sensors communicate with each other or with a central unit, for example by means of a wireless or wired connection, for coordinated processing of the obtained measured values.

The system for determining the calorie balance of a subject according to the invention is characterized in that it comprises the activity monitor set forth, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure. This system can provide accurate calorie balance because the activity parameter is determined with a high degree of accuracy.

The method according to the invention is characterized in that

- the method further comprises the step of determining ~~the position of~~ on which body part the sensor is attached ~~on the subject by analyzing a signal from the sensor for features that are position dependent~~, and

- the step of deriving the subject-related value is performed also in dependence on the position of the sensor on the subject.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the method of the invention will be further elucidated and described with reference to the drawing, in which:

Figs. 1 A,B,C,D show sketches of a device with attachment means that can be attached at several positions on a subject.

Fig. 2 shows an activity monitor with user interface.

Fig. 3 shows an activity monitor comprising a device with a sensor connected to a separate unit by means of a wireless link.

Fig. 4 shows a diagram of an embodiment of the method according to the invention.

Figs. 5 A,B show diagrams of embodiments of the measuring method according to the invention including the compensation method according to the invention.

Fig. 6 shows a diagram of an embodiment of the method according to the invention including the method according to the invention to determine the position of the sensor on the subject.

Fig. 7 shows a diagram of an embodiment of the method according to the invention including the compensation initialization method according to the invention.

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Letter accompanying subsequently filed items

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The document(s) listed below is (are) subsequently filed documents pertaining to the following application:

Application number	06832085.2
Applicant's or representative's reference	PH003603EP2

	Description of document	Original file name	Assigned file name
1	Reply to examination report	PH003603 EP2 brf EPO (22.12).pdf	EXRE3-1.pdf
2	Amended description	PH003603EP2 Amended pages 3, 6, 6a and 8.pdf	DESCPAMD-1.pdf
3	Amended claims	PH003603 EP2 claims main req. marked-up (22.12).pdf	CLMSPAMD-1.pdf
4	Amended claims	PH003603 EP2 claims main req. clean (22.12).pdf	CLMSPAMD-2.pdf
5	Amended claims	PH003603 EP2 claims 1st aux req. marked-up (22.12).pdf	CLMSPAMD-3.pdf
6	Amended claims	PH003603 EP2 claims 1st aux req. clean (22.12).pdf	CLMSPAMD-4.pdf
7	Amended claims	PH003603 EP2 claims 2nd aux req. marked-up (22.12).pdf	CLMSPAMD-5.pdf
8	Amended claims	PH003603 EP2 claims 2nd aux req. clean (22.12).pdf	CLMSPAMD-6.pdf
9	Amended claims	PH003603 EP2 claims 3rd aux req. marked-up (22.12).pdf	CLMSPAMD-7.pdf
10	Amended claims	PH003603 EP2 claims 3rd aux req. clean (22.12).pdf	CLMSPAMD-8.pdf

Signatures

Place:	**Eindhoven**
Date:	**22 December 2010**
Signed by:	**NL, Philips IP&S, S. Cumpson 17365**
Capacity:	**(Koninklijke Philips Electronics N.V.)**

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Ref: PH003603EP2
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Date: 2010-12-22

Re: European Patent Application No. 06 780 063.1 – 1225
Applicant: Koninklijke Philips Electronics N.V.

We refer to the Communication pursuant to Article 94(3) dated 3 September 2010 and hereby submit our response to the above Communication. We enclose two amended claim sets i.e. a main request and four auxiliary requests. For your convenience we enclose both clean copies of the claim sets as well as copies with indication of the amendments.

Main Request

Claim amendments

For the purpose of indicating proper support for the amendments to the application as filed, reference is made to the application text as originally filed, using the notation [page No.; first line - last line], e.g. [7; 14-23].

1. In claim 1 we have specified the unclear formulation of the attachment of a sensor on various parts of the body of a subject (person) by replacing the formulation "*plurality of positions*" by "*plurality of body parts*". This amendment is based in original claims 1, 2 and 5 (PCT publication pamphlet), as well as in the description (PCT publication pamphlet) [3; 27-34], [4; 6-10], [4; 21-30], [5; 5-13], and [7; 10-19].
2. Further, in claim 1, we have removed the ambiguity incorporated in the formulation "*…one of a plurality of…*" by deleting "*one of*". Thus it is clear that the system has means to secure the sensor to a variety of body parts, and not just a specific body part. This amendment is based in claim 2 and 5 (PCT publication pamphlet), and the description (PCT publication pamphlet), e.g. [3; 27-34]; and Figs. 1B-D.
3. Further, in claim 1 we have deleted the feature "*by analyzing a signal from the sensor for features that are position dependent*". This feature was not part of the original claim, and the amendment is thus based in claim 1 as filed.
4. A new claim 8 has been introduced. The new claim 8 has basis in claim 9 of PCT-application.
5. Claims 8-15 have been renumbered and the claim dependencies have been altered accordingly.

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6. In the independent method claim, claim 15 – now claim 16 – we have made amendments corresponding to the amendments in claim 1.
7. In the dependent claims 2, 6, 9-13, and 15 we have amended the wording to correspond to the amended formulation of claim 1.

Article 123(2)
By removing the phrase "*by analyzing a signal from the sensor for features that are position dependent*" from claims 1 and 16, we find that the amended claims overcomes the objection that the claim introduces subject matter as stated under Item 1 of the Communication.
We also find that the specification of the positions on a subject to be related to "body parts" of a subject, is in accordance with all of the embodiments described in the application as filed.

Article 84
The removal of the phrase "*by analyzing a signal from the sensor for features that are position dependent*" from claims 1 and 16 further overcomes the objection that the claims are not supported by the description as stated under Item 2 of the Communication.
The description refers to different types of sensors: temperature sensor, ECG sensor, and acceleration sensor, see page 4, line 11 – page 5, line 27. The embodiments described in the detailed part of the description are examples. A person skilled in the art may – on the basis of the description and claims – implement algorithms and rules based on physical or physiological characteristics of various body parts and on the technological capabilities of other types of sensors. We therefore find that the term "*sensor*" is fully supported by the description.
Further, we find that the specification of the positions on a subject to be related to "body parts" of a subject, is fully supported and in accordance with all of the embodiments described in the application as filed.

Article 83
We find that, since the objection regarding support (see the above section "Article 84" has been overcome, the presented claims amendment also overcome the objection to clarity in Item 4 of the Communication.

Novelty
The amended claim 1 defines a measuring system comprising a sensor for obtaining a measured value representing a physical quantity of a body part of a subject. With the measured value and dependent on the position of the sensor, in the sense of which body part the sensor is attached to, a related value is derived. The measured value is also used to determine the position of said sensor on the subject, dependant on the body part where the sensor is attached.

D1 (US 5,111,826) discloses a method of determining the absolute blood pressure. In the method various sensors are used, see claim 1. A piezo electric pressure transducer is clamped onto a finger, and an ultrasonic hand position / height sensor produces a pressure signal to

the hand and heart levels, see claims 1 and 2, and column 7, par. 2. This pressure signal obtained with the position / height sensor is used for correction, see last step of method claim 1 and column 4, lines 42 – 50. D1 discloses that the signal of another sensor, the position / height sensor, is used to determine the hand position (difference in height between the hand and the heart, column 3 lines 43, 44).

D1 does not disclose a device that may be attached to various body parts. D1 does not disclose that a value measured by the piezo electric transducer on an unspecified body part may be used to determine to which body part the sensor is attached. Further D1 does not disclose that the determination of the body part may provide a subject related value, based on the determined body part. D1 does not disclose that the signal of the piezo electric transducer is analyzed for features that are dependent on the body part to which is attached.

Hence claim 1 is novel in view of D1.

The independent method claim 16 includes corresponding features. Consequently, also claim 16 is novel in view of D1.

D2 (EP 1 254 629A1) discloses an electric sphygmomanometer comprising measuring means placed on a predetermined region and measures blood pressure and posture detecting means for detecting a posture of a person, see claim 1. The blood pressure is determined using a pressure sensor for detecting an air pressure in the cuff, see [0021]. The posture detecting means has an angle detector 11 [0021] or gravitational acceleration sensors [0055]. D2 discloses that the signal of another sensor, for example the acceleration sensor, is used to determine an altitude difference between the heart and the reference position, see [0056].

D2 does not disclose a device that may be attached to various body parts. D2 does not disclose that a value measured by the pressure sensor in the cuff may be used to determine to which body part the sensor is positioned. Hence claim 1 is novel in view of D2. Further D2 does not disclose that the determination of the body part may provide a subject related value, based on the determined body part.

Hence claim 1 is novel in view of D2.

The independent method claim 16 includes corresponding features. Consequently, also claim 16 is novel in view of D2.

Inventive step

As is also described above, D1 discloses a method for determining blood pressure, which is also a measured value representing a physical quantity of a subject. D1 is regarded to be in the same field as the invention and is assumed to be the closest prior art.

The distinguishing feature of the invention is defined in the characterizing portion of the amended claim 1.

This feature provides the effect that regardless of which body part the sensor for obtaining a measured value representing a physical quantity was attached to the subject, the body part may be determined, enabling the measuring system to yield a more accurate estimation of a parameter relating to the subject (pg 3 lines 18, 19).

The objective technical problem is to obtain a more accurate estimation of a measured value representing a physical quantity of a subject using a sensor that may be attached to a plurality of body parts of said subject.

D1 discloses a method to enhance the accuracy of the measurement by including a correction based on signals obtained from another sensor i.e. the hand position /height sensor attached to a specific and non-alterable body part. Thus D1 teaches away from using the measured value from the sensor itself to determine to the body part to which the sensor is attached. Instead it suggests to add a hand position sensor and use the output signal from that sensor to correct the measurement value obtained from the piezoelectric pressure sensor.

Even if the skilled person would consult D2 he would find there a confirmation of the teaching of D1. Also in D2 it is suggested to use additional sensors to obtain data on relative positions of body parts that can be used to enhance the accuracy of the blood pressure sensor.

In view of the aforementioned considerations it is submitted that new claim 1 is also inventive over D1 and D2.

The independent method claim 15 includes corresponding features. Consequently, also claim 16 is inventive over D1 and D2.

Amendments to the description

We enclose replacement pages 3 and 8 in order to bring the application into conformity with the amended claims. Further we enclose replacement pages 6 and 6a, in which we reintroduce the subject matter cancelled in connection with the response to the previous Communication. The subject matter is base on the description as filed, page 5, lines 28-32 (PCT-pamphlet).

1st Auxiliary request

Claim amendments

The amendments to the set of claims, as well as the basis for the amendments, are identical to the Main Request above, with the exception that the term “sensor” has been replaced by the term “accelerometer”. This amendment is based in original claim 5 (PCT publication pamphlet), as well as in the description (PCT publication pamphlet) [4; 31-33], [5; 6] and [8; 33 – 9; 3]. Further, this amendment is in accordance with the all the embodiments described from page 9, line 23- page 14, line 27, see e.g. [9; 26].

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Article 123(2)
The amendments to the set of claims overcome the rejection based on Article 123(2), EPC, for the same reasons as for the main request above.

Article 84
The removal of the phrase "*by analyzing a signal from the sensor for features that are position dependent*" from claims 1 and 16 further overcomes the objection that the claims are not supported by the description as stated under Item 2 of the Communication.

Further, we have specified the sensor type by adding the feature that the sensor is an accelerometer. This amendment is in accordance with the specific embodiments described in the detailed part of the description. Therefore, the amended claims 1 and 16 further overcomes the objection that the claims are not supported by the description as stated under Item 2 of the Communication.

Further, we find that the specification of the positions on a subject to be related to "body parts" of a subject, is fully supported and in accordance with all of the embodiments described in the application as filed.

Article 83
We find that, since the objection regarding support (see the above section "Article 84" has been overcome, the presented claims amendment also overcome the objection to clarity in Item 4 of the Communication.

Novelty
The amendments to the set of claims overcome the novelty rejection for the same reasons as for the main request above.

Inventive step
The amendments to the set of claims overcome the inventive step rejection for the same reasons as for the main request above.

Amendments to the description
We respectfully submit the same replacement sheets as with the main request above.

2nd Auxiliary request

Claim amendments
For the purpose of indicating proper support for the amendments to the application as filed, reference is made to the application text as originally filed, using the notation [page No.; first line - last line], e.g. [7; 14-23].

1. In claim 1 we have specified the unclear formulation of the attachment of a sensor on various parts of the body of a subject (person) by replacing the formulation "*plurality*

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of positions" by "*plurality of body parts*". This amendment is based in original claims 1, 2 and 5 (PCT publication pamphlet), as well as in the description (PCT publication pamphlet) [3; 27-34], [4; 6-10], [4; 21-30], [5; 5-13], and [7; 10-19].

2. Further, in claim 1, we have removed the ambiguity incorporated in the formulation "*…one of a plurality of…*" by deleting "*one of*". Thus it is clear that the system has means to secure the sensor to a variety of body parts, and not just a specific body part. This amendment is based in claim 2 and 5 (PCT publication pamphlet), and the description (PCT publication pamphlet), e.g. [3; 27-34]; and Figs. 1B-D.
3. Further, in claim 1 we have supplemented the feature "*by analyzing a signal from the sensor for features that are position dependent*" with the feature that this is done "*on the basis of a predefined set of rules related to the measured value*". This amendment is based in original claims 1, 9 and 11 (PCT publication pamphlet), as well as in the description (PCT publication pamphlet) [11; 8-15] and [11; 33 – 12; 15].
4. A new claim 8 has been introduced. The new claim 8 has basis in claim 9 of PCT-application.
5. Claims 8-15 have been renumbered and the claim dependencies have been altered accordingly.
6. In the independent method claim, claim 15 – now claim 16 – we have made amendments corresponding to the amendments in claim 1.
7. In the dependent claims 2, 6, 9-13, and 15 we have amended the wording to correspond to the amended formulation of claim 1.

Article 123(2)

By adding the feature "*on the basis of a predefined set of rules related to the measured value*" the feature "*by analyzing a signal from the sensor for features that are position dependent*" in claims 1 and 16, we find that the amended claims overcomes the objection that the claim introduces subject matter as stated under Item 1 of the Communication. The feature of "signal analysis is thus brought into the context under which it is described in the description and original claims. We note that in the cited passage of the description, [11; 33 – 12; 15], the features of the passage [11; 8-15] relating to the figure 6 embodiment, are repeated for the figure 5 embodiments. It is thus clear that the signal analysis feature is also valid for these embodiments. Consequently the amendment is not a generalization.
We also find that the specification of the positions on a subject to be related to "body parts" of a subject, is in accordance with all of the embodiments described in the application as filed.

Article 84

Under the sections "Claim amendments" and "Article 123(2)" above we have provided basis and argument for the amended claims 1 and 16. We therefore submit that the amendments to claims 1 and 16 overcomes the objection that the claims are not supported by the description as stated under Item 2 of the Communication.

The description refers to different types of sensors: temperature sensor, ECG sensor, and acceleration sensor, see page 4, line 11 – page 5, line 27. The embodiments described in the

detailed part of the description are examples. A person skilled in the art may – on the basis of the description and claims – implement algorithms and rules based on physical or physiological characteristics of various body parts and on the technological capabilities of other types of sensors. We therefore find that the term "*sensor*" is fully supported by the description.

Further, we find that the specification of the positions on a subject to be related to "body parts" of a subject, is fully supported and in accordance with all of the embodiments described in the application as filed.

Article 83
We find that, since the objection regarding support (see the above section "Article 84" has been overcome, the presented claims amendment also overcome the objection to clarity in Item 4 of the Communication.

Novelty and inventive step
The amended claims 1 and 16 are novel and inventive for the same reasons as provided in the main request above.

Further, we submit that none of the documents D1 or D2 shows the additional features "*by analyzing on the basis of a predefined set of rules related to the measured value a signal from the accelerometer for features that are position dependent*".

D1 discloses a method for determining blood pressure, which is also a measured value representing a physical quantity of a subject. D1 is regarded to be in the same field as the invention and is assumed to be the closest prior art.

The distinguishing feature of the invention is defined in the characterizing portion of new claim 1.

This feature provides the effect that regardless of where the sensor for obtaining a measured value representing a physical quantity was attached to the subject its position may be determined, enabling the measuring system to yield a more accurate estimation of a parameter relating to the subject (pg 3 lines 18, 19).

The objective technical problem is to obtain a more accurate estimation of a measured value representing a physical quantity of a subject using a sensor that may be attached to a plurality of positions on said subject.

D1 discloses a method to enhance the accuracy of the measurement by including a correction based on signals obtained from another sensor i.e. the hand position /height sensor. Thus D1 teaches away from using the signal of the sensor itself and analyze is for features that are position dependent. Instead it suggests to add a hand position sensor and

use the output signal from that sensor to correct the measurement value obtained from the piezoelectric pressure sensor.

Even if the skilled person would consult D2 he would find there a confirmation of the teaching of D1. Also in D2 it is suggested to use additional sensors to obtain data on relative positions of body parts that can be used to enhance the accuracy of the blood pressure sensor.

In view of the aforementioned considerations it is submitted that new claims 1 and 16 is also inventive over D1 and D2.

3rd Auxiliary request

The amendments to the set of claims, as well as the basis for the amendments, are identical to the 2nd Auxiliary Request above, with the exception that the term "sensor" has been replaced by the term "accelerometer". This amendment is based in original claim 5 (PCT publication pamphlet), as well as in the description (PCT publication pamphlet) [4; 31-33], [5; 6] and [8; 33 – 9; 3]. Further, this amendment is in accordance with the all the embodiments described from page 9, line 23- page 14, line 27, see e.g. [9; 26].

Article 123(2)

The amendments to the set of claims overcome the rejection based on Article 123(2), EPC, for the same reasons as for the 2nd Auxiliary Request above.

Article 84

The amendments to the set of claims overcome the rejection based on Article 123(2), EPC, for the same reasons as for the 2nd Auxiliary Request above.

Further, we have specified the sensor type by adding the feature that the sensor is an accelerometer. This amendment is in accordance with the specific embodiments described in the detailed part of the description. Therefore, the amended claims 1 and 16 further overcomes the objection that the claims are not supported by the description as stated under Item 2 of the Communication.

Further, we find that the specification of the positions on a subject to be related to "body parts" of a subject, is fully supported and in accordance with all of the embodiments described in the application as filed.

Article 83

We find that, since the objection regarding support (see the above section "Article 84" has been overcome, the presented claims amendment also overcome the objection to clarity in Item 4 of the Communication.

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Novelty

The amendments to the set of claims overcome the novelty rejection for the same reasons as for the 2nd auxiliary request above.

Inventive step

The amendments to the set of claims overcome the inventive step rejection for the same reasons as for the 2nd auxiliary request above.

Amendments to the description

We respectfully submit the same replacement sheets as with the main request above.

4th Auxiliary request

It is believed that by the above amendments of the claims, and the description, and in view of the above argumentation, the application now fulfils the requirements of the EPC, and favourable consideration of the application is requested. As a precaution, however, we request that oral proceedings in accordance with Art. 116 EPC be arranged prior to issuance of any adverse decision.

General

This response and the enclosed submissions do not imply the abandonment of any subject-matter previously filed in relation to this application, and the applicant reserves the right to re-instate any cancelled subject-matter and/or to file divisional applications pursuant to Art. 76 EPC, including any cancelled subject-matter.

The Professional Representative,

H.C.P.M. van Iersel

Encl.: Amended pages 3, 6, 6a and 8 (only marked-up version)
Amended claims main request (marked-up and clean version)
Amended claims 1st auxiliary request (marked-up and clean version)
Amended claims 2nd auxiliary request (marked-up and clean version)
Amended claims 3rd auxiliary request (marked-up and clean version)

1 Claims 1 and 15 introduce subject-matter which extends beyond the content of the application as filed, contrary to Article 123(2) EPC. The amendment concerned is the following: "analyzing a signal from the sensors for features that are position dependent". According to the applicant, basis can be found i. a. on 11, lines 11-15 of the PCT publication. However, this passage refers to a particular algorithm for determining the position, from which the objected feature was taken in isolation. The feature is thus an unallowable generalisation of the described embodiment. Further basis was given in claim 9 presently on file, which corresponds to published claim 11. This claim 11 was dependent on claim 9 and refers to a set of predetermined rules. The feature is thus an unallowable generalisation of the claim.

2 Claims 1 and 15 are not supported by the description as required by Article 84 EPC, as its scope is broader than justified by the description and drawings, see also Guidelines C-III 6.3.

The description exclusively relates to accelerometers as sensors, while the claims cover any sensor type. However, on the basis of the information provided in the application, i.e. the algorithms for analysing the accelerometer signals for particular patterns, it is not possible to extend the particular teaching by using routine methods of experimentation or analysis. For blood pressure sensors, e.g., it is generally considered necessary to use a separate sensor for determining the position of the blood pressure sensor, such as in D2 or D1.

3 The objection on lack of support also results in an objection under Art. 83, see Guidelines C-III 6.4, for the same reasons.

4 The present application does not meet the requirements of Article 52(1) EPC because the subject-matter of claim 1 is not new within the meaning of Article 54(1) and (2) EPC.

4.1 D1 discloses a measuring system comprising

- a sensor (hand position sensor; col. 7, par. 2) arranged to be attached at one of a plurality of positions (different distances from the finger tip) on a subject for obtaining a measured value representing a physical or a physiological quantity of the subject (the sensor is used to determine the height of the finger

with respect to the heart, thus by holding the finger vertically at a predetermined height, the distance of the sensor from the finger tip can be determined, this being the physical quantity), and

- means for determining the position of the sensor on the subject (the position determined above) by analyzing a signal from the sensor for features that are position dependent (the pressure in case of the saline-filled tube), and

- means for deriving a subject-related value (the position determined above) from the measured value in dependence on the position of the sensor on the subject (inherently).

4.2 The same argumentation applies with respect to D2, using the position on the arm instead of the finger.

4.3 The subject-matter of claim 1 and claim 15 mutatis mutandis is therefore not new (Article 54(1) and (2) EPC).

5 Amended claims may not relate to unsearched subject-matter which does not combine with the originally claimed invention to form a single general inventive concept (Rule 137(4) EPC).

It is considered that the applicant had had the opportunity to amend the claims under Rule 137(3) EPC, first sentence. Newly-filed claims in response to this or further communications need the consent of the Examining Division, see Rule 137(3), second sentence. In particular, the division might consider not to accept amendments that contain a *shift* in the claimed subject-matter.

6 The applicant is requested to bring the description, in particular the statement of invention, into conformity with amended claims, Rule 42(1)(c) and Art. 84 EPC.

7 The applicant is requested to effect the amendments by filing replacement pages for only those pages which have been amended. Unnecessary recasting of the description should be avoided. In order to facilitate the examination of the conformity of the amended application with the requirements of Article 123(2) EPC, the applicant is requested to clearly identify the amendments carried out, irrespective of whether they concern

amendments by addition, replacement or deletion, and to ***indicate the passages of the application as filed on which these amendments are based*** (Guidelines E-II 1).

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Applicant: Koninklijke Philips Electronics N.V.		

Communication pursuant to Article 94(3) EPC

The examination of the above-identified application has revealed that it does not meet the requirements of the European Patent Convention for the reasons enclosed herewith. If the deficiencies indicated are not rectified the application may be refused pursuant to Article 97(2) EPC.

You are invited to file your observations and insofar as the deficiencies are such as to be rectifiable, to correct the indicated deficiencies within a period

of 4 months

from the notification of this communication, this period being computed in accordance with Rules 126(2) and 131(2) and (4) EPC. One set of amendments to the description, claims and drawings is to be filed within the said period on separate sheets (R. 50(1) EPC).

If filing amendments, you must identify them and indicate the basis for them in the application as filed. Failure to meet either requirement may lead to a communication from the Examining Division requesting that you correct this deficiency (R. 137(4) EPC).

Failure to comply with this invitation in due time will result in the application being deemed to be withdrawn (Art. 94(4) EPC).

Clevorn, Jens
Primary Examiner
For the Examining Division

Enclosure(s): 3 page/s reasons (Form 2906)

AMENDED SET OF CLAIMS:

1. A measuring system (1) comprising

- a sensor (6) arranged to be attached at one of a plurality of positions on a subject for obtaining a measured value representing a physical or a physiological quantity of the subject,

- means for deriving a subject-related value from the measured value in dependence on the position of the sensor on the subject,

characterized in the measuring system further comprising

- means for determining the position of the sensor on the subject by analyzing a signal from the sensor for features that are position dependent.

2. The measuring system (1) according to claim 1, wherein the plurality of positions includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head.

3. The measuring system (1) according to claim 1, wherein the derived value comprises an activity parameter of the subject

, the activity parameter comprising energy expenditure.

4. The measuring system (1) according to claim 1, wherein the activity parameter represents a degree of activity of the body part the sensor is attached to.

5. The measuring system (1) according to claim 1, wherein the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration.

6. The measuring system (1) according to claim 1, further comprising means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on the position of the sensor on the subject, and the sensor is arranged for generating a further measured value for each quantity in the selected subset.

7. The measuring system (1) according to claim 1, further comprising

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

8. The measuring system (1) according to claim 1, further comprising means for obtaining from the sensor (6) a plurality of measured values measured during a time interval, and wherein the means for determining the position of the sensor on the subject is arranged for performing the determining in dependence on the measured values measured during the time interval.

9. The measuring system (1) according to claim 1 or 8, wherein the means for determining the position of the sensor (6) on the subject is arranged for performing the determining on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively.

10. The measuring system (1) according to claim 8, wherein the means for determining the position of the sensor (6) on the subject comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval.

11. The measuring system (1) according to claim 1 or 8, further comprising means for determining that the user is performing a standardized activity, and wherein the means for determining the position of the sensor on the subject is arranged for using at least one measured value obtained from the sensor (6), the measured value relating to a time the user is performing the standardized activity.

12. The measuring system (1) according to claim 1, further comprising a user interface for receiving input from a user related to the position of the sensor on the subject.

13. The measuring system (1) according to claim 1, further comprising

- means for establishing that the subject is performing a predetermined activity,

- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,

- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and

- means for providing feedback in dependence on the similarity measure.

14. A system for determining the calorie balance of a subject, the system comprising the measuring system (1) according to claim 4, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure.

15. A method of estimating a derived value relating to a subject, the method comprising

- obtaining at least one measured value from a sensor (6) attached to the subject, the measured value representing a physical or a physiological quantity of the subject, and

- determining the position of the sensor on the subject by analyzing a signal from the sensor for features that are position dependent, and

- deriving the subject-related value from the measured value also in dependence on the position of the sensor on the subject.

AMENDED SET OF CLAIMS:

1. A measuring system (1) comprising

- a sensor (6) arranged to be attached at one of a plurality of positions on a subject for obtaining a measured value representing a physical or a physiological quantity of the subject,

~~and~~

~~- means for establishing the position of the sensor on the subject, and~~

- means for deriving a subject-related value from the measured value ~~also~~ in dependence on the position of the sensor on the subject,

characterized in the measuring system further comprising

- means for determining the position of the sensor on the subject by analyzing a signal from the sensor for features that are position dependent.

2. The measuring system (1) according to claim 1, wherein the plurality of positions includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head.

3. The measuring system (1) according to claim 1, wherein the derived value comprises an activity parameter of the subject

.

~~4. The measuring system (1) according to claim 3, wherein~~ the activity parameter ~~comprises~~ comprising energy expenditure.

~~5~~4. The measuring system (1) according to claim 1, wherein the activity parameter represents a degree of activity of the body part the sensor is attached to.

~~6~~5. The measuring system (1) according to claim 1, wherein the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration.

~~7~~6. The measuring system (1) according to claim 1, further comprising means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on the position of the sensor on the subject, and the sensor is arranged for generating a further measured value for each quantity in the selected subset.

~~8~~7. The measuring system (1) according to claim 1, further comprising

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and
- means for deriving the subject-related value from the estimated measured value.

~~9. The measuring system (1) according to claim 1, wherein the means for determining the position of the sensor on the subject is arranged for performing the determining in dependence on the measured value.~~

~~10~~8. The measuring system (1) according to claim ~~9~~1, further comprising means for obtaining from the sensor (6) a plurality of measured values measured during a time interval, and wherein the means for determining the position of the sensor on the subject is arranged for performing the determining in dependence on the measured values measured during the time interval.

~~11~~9. The measuring system (1) according to claim ~~9~~ 1 or ~~10~~8, wherein the means for determining the position of the sensor (6) on the subject is arranged for performing the determining on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively.

~~12~~10. The measuring system (1) according to claim ~~10~~8, wherein the means for determining the position of the sensor (6) on the subject comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval.

~~13~~11. The measuring system (1) according to claim ~~9~~ 1 or ~~10~~8, further comprising means for determining that the user is performing a standardized activity, and wherein the

means for determining the position of the sensor on the subject is arranged for using at least one measured value obtained from the sensor (6), the measured value relating to a time the user is performing the standardized activity.

~~14. The measuring system (1) according to claim 13, wherein the means for determining that the user is performing a standardized activity is arranged for performing the determining in dependence on at least one measured value.~~

~~15. The measuring system (1) according to claim 13, further comprising a user interface for receiving input from a user to indicate when the subject is performing the standardized activity.~~

~~16~~12. The measuring system (1) according to claim 1, further comprising a user interface for receiving input from a user related to the position of the sensor on the subject.

~~17~~13. The measuring system (1) according to claim 1, further comprising

- means for establishing that the subject is performing a predetermined activity,
- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,
- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and
- means for providing feedback in dependence on the similarity measure.

~~18. The measuring system (1) according to claim 17, wherein the means for establishing that the subject is performing the predetermined activity is arranged for establishing that the subject is performing at least one of a predetermined number of predetermined activities.~~

~~19. A measuring system (1) according to claim 1, further comprising a further sensor arranged to be attached to the subject for obtaining a further measured value representing a further physical or physiological quantity of the subject, and wherein the means for deriving the subject-related value is arranged for deriving the measured value also in dependence on the further measured value.~~

~~20~~14. A system for determining the calorie balance of a subject, the system comprising the measuring system (1) according to claim 4, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure.

~~21~~15. A method of estimating a derived value relating to a subject, the method comprising

- obtaining at least one measured value from a sensor (6) attached to the subject, the measured value representing a physical or a physiological quantity of the subject, and

- ~~establishing~~ determining the position of the sensor on the subject by analyzing a signal from the sensor for features that are position dependent, and

- deriving the subject-related value from the measured value also in dependence on the position of the sensor on the subject.

Detection and compensation method for monitoring the place of activity on the body

FIELD OF THE INVENTION

The invention relates to a measuring system comprising

- a sensor arranged to be attached to a subject for obtaining a measured value representing a physical or a physiological quantity of the subject, and

- means for deriving a subject-related value from the measured value.

The invention also relates to a system for determining the calorie balance of a subject, and to a method of estimating a subject-related derived value.

BACKGROUND OF THE INVENTION

Overweight and obesity are growing problems; for example over 60% of the American population can be classified as overweight or obese. Weight gain occurs when a human has a higher energy intake (food) than energy expenditure (resting metabolic rate + activity). Since this unbalance causes the weight gain problem, many weight loss programs require that users log the food consumed and activities done in order to estimate the calorie balance.

Tables and equations exist for converting nutrition values and activities into calorie intake and expenditure, respectively. However, manual calorie counting is a cumbersome process requiring knowledge, time, effort, recording and discipline. Thus, calorie logging is a problem for many people and hence it is a challenge for researchers to find a solution therefore.

In US patent application publication US2003/0065257, a combination of a diet and activity-monitoring device is described for monitoring both the consumption and activity of the subject. Such a monitoring device includes a body activity monitor for monitoring the body activity of the subject. The body activity monitor is operable to output a signal indicative of the subject's body activity. An activity calculator may also be provided, which receives the activity indicative signal and determines body activity level and/or energy expenditure for the subject. The monitoring device may take the form of a wristwatch-style device or a belt or clothing-mounted monitor. The monitoring device may comprise a heart rate monitor. The heart rate of the subject increases with activity and decreases when the

subject is resting. The activity monitor may be calibrated using an indirect calorimeter. The heart rate sensor may be part of the wristwatch-style activity monitor, or it may be provided as a separate unit, for example in the form of a chest-strap, which communicates with the activity monitor.

The activity monitor may alternatively comprise a motion sensor such as a mechanical pendulum or a single or multi-axis accelerometer. An accelerometer is preferred since it may provide information on body movement as well as the direction and intensity of the movement. The motion sensor may form part of the wristwatch or belt or clothing-mounted monitoring device or may be part of a separate accessory that communicates with the monitoring device. The body activity monitor may be calibrated to determine activity-related energy expenditure using an indirect calorimeter.

As another alternative, the body activity monitor may include multiple modes for recording a variety of activities, such as swimming, biking, and use of stationary exercise equipment. The subject presses a start button and the body activity monitor will record the duration of the activity.

Furthermore, the monitoring device also preferably includes a consumption notation control for use by the subject to indicate when the subject consumes food. The body activity monitor and the consumption notation control may take a variety of forms. It may include a GPS antenna to determine the position of the subject using GPS signals. It may combine a time-indicative signal with the GPS signals to determine changes in position of the subject as well as the rate of change in position. This allows determination of movement or body activity. The device may be calibrated to determine caloric expenditure from the measured body activity.

Moreover, a position and/or activity discriminator may be included in or communicating with the body activity monitor. The discriminator functions to determine the position and/or activity of the subject by determining the proximity of the subject to various devices and locations, such as exercise equipment and buildings. For example, it may be determined that the subject is close to running shoes to discriminate the activity of running. In a more advanced configuration, proximity to running shoes may be combined with GPS signals, heart rate sensor and/or motion sensor output to allow the activity calculator to determine the type of activity being performed, the duration of the activity, and the intensity of the activity.

When the user uses the system for the first time, he or she may designate certain movement patterns as correlating with certain activities. This will aid to calibrate the activity monitor.

Each of the described activity monitors and sensors is designed to be placed on a single position on the body. Bodily signals such as acceleration and ECG signals, are measured local to the position where the sensor is attached to the object. For example, acceleration measured by an accelerometer on the wrist includes motion of the arm, which is not detected by an accelerometer mounted on the waist.

The existing activity monitors, including for example a wrist strap or a waist belt, are often designed to be worn on one place on the body. The existing activity monitor is calibrated such that it provides accurate results if it is attached at a predefined location on the body. If the activity monitor is attached at a different location, the measured activity may be less accurate. If the activity monitor is not attached at the reference position, errors exceeding 5% in the estimation of energy expenditure may occur. This amounts to an error exceeding approximately 100 kilocalories per day.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a measuring system that yields a more accurate estimate of a parameter relating to a subject.

According to the invention, this object is achieved in that

- the sensor is arranged to be attached at one of a plurality of positions on the subject,

- the measuring system further comprises means for ~~establishing~~ determining the position of the sensor on the subject by analyzing a signal from the sensor for features that are position dependent, and

- the means for deriving the subject-related value is arranged for deriving the subject-related value also in dependence on the position of the sensor on the subject.

With these provisions, the accuracy of the derived value is guaranteed for any of a plurality of positions on the body. The subject may attach the sensor at any preferred position on the body, and can preferably attach it at a different position whenever he or she desires to do so.

Subjects may have different preferences where they prefer wearing the sensor, and the same subject may prefer wearing the sensor at different locations, depending on for example the location of the subject, the local weather, or the activity the subject is

performing at any given time. Advantageously, a plurality of sensors are attached at different positions on the subject and the means for deriving the subject-related value is arranged for combining the respective obtained measured values in order to increase the accuracy of the derived value.

It is noted that US 5 111 826 discloses a blood pressure sensor that is worn on one's fingertip and that has a hand position sensor. The hand position sensor measures the difference in height between the hand and the heart to correct the readings from the blood pressure sensor for hand-to-heart differences, whichdifferences directly correspond to differences between finger and heart blood pressure. Document EP 1 254 629 discloses an electronic sphygmomanometer for measuring blood pressure that is worn on one's wrist and has gravitational acceleration sensors to determine altitude differences between the heart and the pressure reference position of the sphygmomanometer for correcting a blood pressure value.

The invention is particularly suitable for determining a derived value relating to a human or an animal.

According to an aspect of the invention, the plurality of positions includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head. This allows for an especially flexible use of the activity monitor, because the positions mentioned are especially well suited for measuring the activity of the subject, and they are particularly convenient for wearing a sensor device.

According to another aspect of the invention, the derived value comprises an activity parameter of the subject. With this aspect, the measuring system becomes an activity monitor that enables to monitor the degree of activity performed by the subject. Other possible derived values include a temperature value or an ECG value that is automatically compensated for by the location of the sensor. Advantageously, the position of the sensor on the subject is established in dependence on an accelerometer measurement and a temperature or ECG value is compensated for in dependence on the established position.

According to an aspect of the invention, the activity parameter comprises energy expenditure. This makes the activity monitor particularly suitable for use in weight management.

According to another aspect of the invention, the activity parameter represents the degree of activity of the body part the sensor is attached to. When the position of the sensor on the subject is known, it becomes possible to monitor activity parameters related to a specific body part. For example, if the sensor is attached to the arm, the activity monitor

can track energy expenditure, and in addition can track local acceleration of the arm. For example, with additional information provided by fitness equipment, the forces applied to the arm can be estimated and combined with acceleration information provided by the sensor to obtain local energy expenditure. This enables subjects to optimize a training schedule to train a specific body part. Also, if a predefined safety limit is exceeded, this can be provided as feedback to the user to avoid potentially dangerous situations.

According to an aspect of the invention, the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration. These examples of measured values are correlated with activity.

According to another aspect of the invention, the system further comprises means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on the position of the sensor on the subject, and the sensor is arranged for generating a further measured value for each quantity in the selected subset. The subset may contain zero or more further physical and/or physiological quantities of the subject, for example temperature, ECG, or acceleration. This aspect allows the system to generate measurements that are particularly relevant to the body part the sensor is attached to. For example, a temperature measurement may provide relevant information when the temperature sensor is attached to the trunk of the body, and not when it is attached to, for example, an ankle. The system can take this into account for example by disregarding, or compensating, temperature measurement if the sensor is attached to an ankle. Further physical and/or physiological quantities, such as heart rate or temperature, can be used alongside for example a derived activity parameter in various health applications.

According to another aspect of the invention, the system further comprises

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

This aspect allows the measuring system to accurately measure, for example, an activity parameter with the sensor at one of a plurality of positions on the subject, even if the measuring system is calibrated for only a single reference position, because the deviation of the measured value caused by wearing the activity monitor at a different position is compensated for. The accuracy may be increased even further by calibrating a plurality of reference positions. In case a plurality of reference positions is calibrated, and the sensor is attached at a position that is not a reference position, the means for converting can

compensate the measured value with respect to the nearest reference position or with respect to a weighted average of reference positions, thereby increasing the accuracy further.

~~Another aspect of the invention is characterized in that the means for determining the position of the sensor on the subject is arranged for determining the position in dependence on the measured value. This allows the sensor to be attached at different positions on the subject, without any additional user interaction to indicate the actual position of the device.~~

According to another aspect of the invention, it further comprises means for obtaining from the sensor a plurality of measured values measured during a time interval, and wherein the means for determining the position of the sensor on the subject is arranged for determining the position in dependence on the measured values measured during the time interval. This allows the position of the sensor to be determined in an especially reliable manner.

According to another aspect of the invention, the means for determining the position of the sensor on the subject is arranged for determining the position on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively. A set of rules, preferably part of a rule-based system, possibly making use of fuzzy logic, is particularly suited for determining the position of the sensor.

According to another aspect of the invention, the means for determining the position of the sensor on the subject comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval. A pattern recognition means is especially favorable to achieve a high reliability in establishing the position of the sensor on the subject.

According to an aspect of the invention, it further comprises means for determining that the user is performing a standardized activity, and the means for determining the position of the sensor on the subject is arranged for using at least one measured value obtained from the sensor, the measured value relating to a time the user is performing the standardized activity. This allows the activity monitor to determine the position of the device on the body with greater certainty. Preferably, the standardized activity has a repetition pattern with a cycle time of, for example, 1 to 2 seconds and the standardized activity is performed for at least five cycles.

According to another aspect of the invention, the means for establishing that the user is performing a standardized activity is arranged for establishing the activity in

dependence on at least one measured value. This increases the accuracy and reduces the amount of required user interaction.

Another aspect of the invention further comprises a user interface for receiving input from a user for indicating when the subject is performing the standardized activity. This allows a very economical implementation of the activity monitor.

Another aspect of the invention further comprises a user interface for receiving input from a user related to the position of the sensor on the subject. This allows a very economical implementation of the activity monitor.

Another aspect of the invention further comprises

- means for establishing that the subject is performing a predetermined activity,
- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,
- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and
- means for providing feedback in dependence on the similarity measure.

If the sensor position and the type of activity are known, the actual body movements can be compared to movements that are “optimal” for that particular activity. This translates into a measure of efficiency and proficiency in the selected activity. For example, inexperienced runners have a larger vertical acceleration component than experienced runners. Optimal movement patterns can be looked up in a database with key (desired activity, body part), and a pattern-matching technique can be used to determine how the actual pattern compares to the optimal pattern. Moreover, suggestions to change movement patterns of the specific body part can be given, such as for example, “when striking a ball with a racket, try to move in a continuous circular motion, and do not stop the motion after impact, to maximize acceleration of the ball upon impact”. Alternatively, movements associated with health problems such as a baseball-arm, can be detected and feedback can be provided about the undesired movements.

According to another aspect of the invention, the means for establishing that the subject is performing the predetermined activity is arranged for establishing that the subject is performing at least one of a predetermined number of predetermined activities. This allows the activity monitor to distinguish between a plurality of activities of the subject, so that feedback can be provided in relation to the established activity.

According to another aspect of the invention, it further comprises a further sensor arranged to be attached to the subject for obtaining a further measured value representing a further physical or physiological quantity of the subject, and wherein the means for deriving the subject-related value is arranged for deriving the measured value also in dependence on the further measured value. Advantageously, a plurality of sensors are attached at different positions on the subject and the means for deriving the subject-related value is arranged for combining the respective obtained measured values in order to increase the accuracy of the derived value. Advantageously, the sensors communicate with each other or with a central unit, for example by means of a wireless or wired connection, for coordinated processing of the obtained measured values.

The system for determining the calorie balance of a subject according to the invention is characterized in that it comprises the activity monitor set forth, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure. This system can provide accurate calorie balance because the activity parameter is determined with a high degree of accuracy.

The method according to the invention is characterized in that

- the method further comprises the step of determining the position of the sensor on the subject by analyzing a signal from the sensor for features that are position dependent, and

- the step of deriving the subject-related value is performed also in dependence on the position of the sensor on the subject.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the method of the invention will be further elucidated and described with reference to the drawing, in which:

Figs. 1 A,B,C,D show sketches of a device with attachment means that can be attached at several positions on a subject.

Fig. 2 shows an activity monitor with user interface.

Fig. 3 shows an activity monitor comprising a device with a sensor connected to a separate unit by means of a wireless link.

Fig. 4 shows a diagram of an embodiment of the method according to the invention.

Figs. 5 A,B show diagrams of embodiments of the measuring method according to the invention including the compensation method according to the invention.

Fig. 6 shows a diagram of an embodiment of the method according to the invention including the method according to the invention to determine the position of the sensor on the subject.

Fig. 7 shows a diagram of an embodiment of the method according to the invention including the compensation initialization method according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1A shows an activity monitor 1 comprising a sensor 6 (shown in dotted lines), a display 10, and strap attachment means 5. The activity monitor 1 further comprises a microprocessor (not shown) for computing and displaying an activity parameter. The sensor 6 can comprise a single-axial or multi-axial accelerometer, a temperature sensor, an electrical sensor for measuring electrical body signals such as the ECG signal, a heart rate sensor, a pedometer, a global or local positioning system, or any other type of sensor. Such sensors are known to the skilled artisan. Figure 1B shows the activity monitor 1, fixed to a short strap 2 with a buckle 4, and Figure 1C shows the activity monitor 1 fixed to a long strap 3. The short strap 2 is suitable for attaching the activity monitor to a wrist or ankle, while the long strap 3 is suitable for attaching the activity monitor to a waist or chest. Figure 1D shows a side view of the activity monitor illustrating a clip 9 fixed to the back of the activity monitor, making it possible to attach the activity monitor to clothing. The activity monitor with accessories as shown can be attached at one of a plurality of positions on a subject. The display 10 can be a touch-screen display for having a subject provide input to the activity monitor.

Figure 2 shows an activity monitor 20 with at least one button 21,22, a display 23, and a sensor 24. The button can be used for receiving input from a user. Preferably, more buttons are provided to make it easier for the subject to provide different kinds of input to the activity monitor.

Figure 3 shows an activity monitor comprising a device 30 with a sensor 33. The device 30 does not have any buttons or display. The device 30 has means to communicate with a separate unit 31, preferably using a wireless link 32 such as WIFI or Bluetooth. The separate unit 31 is used to control the device 30. The separate unit 31, for example a personal computer or a personal digital assistant, comprises a microprocessor (not shown) for processing the information gathered by the device 30 by means of sensor 33. The separate unit 31 further comprises means for receiving user input and communicating the processed information to a user.

Figure 4 shows an embodiment of the method according to the invention for activity monitoring applicable to the case where the sensor 6 is attached at a reference position. In step 100, the sensor 6 delivers a measurement value at the reference position. Preferably, the sensor 6 is a tri-axial accelerometer, and the measurement value is a triple containing acceleration information in X, Y, and Z-direction. In step 101, the activity monitor computes the corresponding activity parameter, for example energy expenditure. For a tri-axial accelerometer attached to the back of the waist, a method to compute the corresponding energy expenditure is disclosed in "Daily physical activity, energy expenditure and physical fitness; assessment and implications" by Guy Plasqui, Ph.D. thesis, Maastricht University, 2004, referred to hereinafter as "Plasqui". The back of the waist is near the center of the body and a tri-axial accelerometer attached thereto provides a good estimation of overall movements.

Figure 5A shows an example of embodiment of the method according to the invention for activity monitoring applicable to the case where the sensor 6 is attached at a position on the subject that is not a reference position. In step 105, the sensor 6 delivers a measurement value measured at the position where the sensor is attached. After this, in step 106, the measurement value is compensated for the difference of the value at the position the sensor 6 is attached and the corresponding value at the reference position. After this, in step 108, the activity parameter, in this case energy expenditure, is computed using the method of computing the corresponding energy expenditure disclosed in Plasqui. The compensation method of step 106, in a very simple version, in this embodiment can be expressed as:

$$x_{corrected} = b + x_{raw},$$

where x_{raw} represents the measured value at the position where the sensor 6 is attached, $x_{corrected}$ is the corrected measured value, and a and b are compensation constants that have been stored in a compensation database 107 as part of an initialization procedure. In a multivariate system, where the measurement value comprises a tuple, for example the X, Y, and Z-components measured by a tri-axial accelerometer, the compensation method can be expressed as:

$$x_{corrected} = a + x_{raw},$$

where $x_{raw,1}, x_{raw,2}, x_{raw,N}$ represent the N components of the measurement value tuple; $x_{corrected,i}$ represents the i-th component of the corrected measurement value tuple $(x_{corrected,1}, x_{corrected,2}, x_{corrected,N})$, and a_i and $b_{i,j}$, for $i, j = 1, 2, \ldots, N$, are compensation

constants that have been stored in a compensation database 107 as part of an initialization procedure. This example of a compensation method is particularly easy to implement. Other, potentially more flexible compensation methods are easily conceivable. Such methods include higher order polynomials, generalized linear models, other statistical methods, artificial neural networks, and fuzzy logic methods.

Figure 5B shows an alternative embodiment of the method according to the invention for activity monitoring applicable to the case where the sensor 6 is attached at a position on the subject that is not a reference position. In step 110, the sensor 6 delivers a measurement value measured at the position where it is attached. After this, in step 111, the activity parameter, in this case energy expenditure, is computed using the method of computing the corresponding energy expenditure disclosed in Plasqui. Finally, in step 112 the computed energy expenditure is compensated for the difference of the energy expenditure as computed from the value measured at the position where the sensor 6 is attached and the "real" energy expenditure that would have been obtained if the sensor had been attached at the reference position. The compensation method, which is similar to the compensation method appearing in the embodiment according to Figure 5A, makes use of the information stored in the compensation database 113.

Figure 6 shows a diagram of an embodiment of a method of determining the position on the subject where the sensor 6 is attached and of computing the activity parameter, regardless of where the sensor was attached. In step 115, the measured value or a sequence of measured values is obtained from the sensor 6. Next, the position on the body is determined in step 116, using information from a feature database 117. To determine the position of the sensor 6 on the body, the signal from the sensor is analyzed for features that are position-dependent. Also, the subject is instructed to perform predefined standardized activities, such as walking, sitting, and standing, preferably for about 20 seconds each. Alternatively, the user can provide the activity monitor with input to indicate when he or she performs a standardized activity, and possibly, which standardized activity he or she performs. Combinations of the values during the standardized activities or the absolute measured values are used to determine the position of the sensor 6 on the subject. Thereto, a number of predefined rules are used. These rules can be in the form of "if…then" rules. An example of such a rule is: "if the measured value during walking is in the range of A to B times higher than during sitting, the sensor 6 is positioned on the lower arm", where A and B are constants stored in the feature database 117. Another example of such a rule is: "if the measured value during walking is in the range of C to D, the sensor 6 is positioned on the

leg", where *C* and *D* are constants stored in the feature database 117. The rules can also be implemented in terms of fuzzy logic rules. Other ways to provide a set of rules, including for example neural network methods and logic programming, are obvious to the skilled artisan. In a preferred embodiment, the position of the sensor 6 on the subject is determined by means of pattern recognition. The pattern recognition can be performed for example by correlating a signal obtained from the sensor with a signal stored in the feature database 117. The pattern recognition can be performed in the time domain, the frequency domain, or another domain, preferably a time-frequency domain such as a wavelet domain. Pattern recognition can be performed in many ways known to the skilled artisan. For example, techniques used in speech recognition can be applied.

After the position of the sensor 6 on the subject has been determined in step 116, and the position is not a reference position (step 118, branch 122), in step 119 the measured value is compensated for by the difference between the value at the position at which the sensor is attached and the corresponding value at a reference position, making use of the information in a compensation database 120, in a way similar to the embodiment according to Figure 5A. Finally, in step 121 the activity parameter is computed from the, possibly compensated, measured value, in a way similar to the embodiment according to Figure 5.

In another embodiment, the measured value is first converted to an activity parameter, and the activity parameter is used to determine the position of the sensor 6 on the subject in a way similar to what is described above. In that case, after the position has been determined, the computed activity parameter is compensated for the difference between the computed activity parameter and the corresponding activity parameter computed from a value measured at a reference position, while information stored in a compensation database is made use of in a way similar to the embodiment according to Figure 5B. It is also possible to use other quantities relating to measured values obtained from the sensor 6, in the step to determine the position 116 and/or in the step to compensate for the difference 119.

Figure 7 shows a diagram of an embodiment of an initialization procedure for the compensation database. In this embodiment, a sequence of steps is performed iteratively. As a first step 130, *i* and *j* are both initialized to 1. Each iteration starts with step 131 comprising an instruction to the subject to perform predefined activity *i*. The instruction can comprise a spoken instruction to walk, sit, or stand, or it can for example comprise showing the activity on a display for a predefined duration. Then, in step 132 the subject performs the predefined activity *i*, while the sensor 6 attached at position *j* on the subject measures a

physical value, in this case tri-axial acceleration, in step 133. Next, in step 134 the essential features are extracted from the measured value signal and stored in a feature database 135. These essential features may comprise decision rules or constants that are part of decision rules, similar to the constants *A*, *B*, *C*, and *D* appearing in the description of the embodiment according to Figure 6. Similarly, essential signal patterns can be stored in the time domain, frequency domain, time-frequency domain, or any other domain or combination of domains. Simultaneously, if position *j* is not a reference position (step 136, branch 145), in step 137 compensation parameters describing the difference between the measured value at the position of the sensor 6 on the subject and the corresponding value at a reference position are determined and stored in a compensation database 138. These compensation parameters may comprise constants appearing in the compensation method, similar to the constants a, b, a_i, and $b_{i,j}$ occurring in the description of the embodiment according to Figure 5A.

To conclude an iteration, *i* is increased in step 139, and if *i* is smaller than or equal to the number of predefined activities (step 140, branch 147), the iteration steps are repeated; otherwise, *j* is increased in step 141, and if *j* is smaller than or equal to the predefined number of positions (step 142, branch 148), *i* is set to 1 in step 143 and the iteration steps are repeated. If *j* is greater than the predefined number of positions (step 142, branch 149), the initialization procedure is finished.

In general, this sequence could be paralleled further, for example by using a plurality of sensors 6 to measure the value at a plurality of positions on the subject simultaneously. In this embodiment, the steps of extracting compensation parameters and extracting essential signal features are performed in parallel. However, they can also be performed sequentially. In an alternative embodiment, the activity parameter is computed after the sensor 6 has delivered the signal in step 133, and before extracting essential features in step 134 and determining compensation parameters in step 137. It is also possible to compute at least one derived quantity from the values measured by the sensor 6, and perform the steps of extracting essential features and determining compensation parameters based on the derived quantity.

In another embodiment, the initialization of the compensation database and the feature database are performed on the basis of a population of subjects. All subjects are asked to perform the standardized activities, the measured values are obtained from the sensor 6 at multiple positions on the subject, and after the data of all subjects have been collected and stored in an intermediate database, the compensation database and the feature database are

filled with values that are representative of the population. This embodiment has the advantage that the activity monitor needs to be initialized only once, possibly by the manufacturer, and after that an unlimited number of activity monitors can be produced using the same database values.

It will be appreciated that the invention also extends to computer programs, particularly computer programs on or in a carrier, adapted for putting the invention into practice. The program may be in the form of source code, object code, a code intermediate source and object code such as partially compiled form, or in any other form suitable for use in the implementation of the method according to the invention. The carrier may be any entity or device capable of carrying the program. For example, the carrier may include a storage medium, such as a ROM, for example a CD ROM or a semiconductor ROM, or a magnetic recording medium, for example a floppy disc or hard disk. Further, the carrier may be a transmissible carrier such as an electrical or optical signal, which may be conveyed via electrical or optical cable or by radio or other means. When the program is embodied in such a signal, the carrier may be constituted by such cable or other device or means. Alternatively, the carrier may be an integrated circuit in which the program is embedded, the integrated circuit being adapted for performing, or for use in the performance of, the relevant method.

A measuring system comprises a sensor arranged to be attached to a subject for obtaining a measured value representing a physical or a physiological quantity of the subject. The measuring system further comprises means for deriving a subject-related value from the measured value. The sensor is arranged to be attached at one of a plurality of positions on the subject. The measuring system further comprises means for establishing the position of the sensor on the subject. The means for deriving the subject-related value is arranged for deriving the subject-related value also in dependence on the position of the sensor on the subject.

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. Use of the verb "to comprise" and its conjugations does not exclude the presence of elements or steps other than those stated in a claim. The article "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. The invention may be implemented by means of hardware comprising several distinct elements, and by means of a suitably programmed computer. In the device claim enumerating several means, several of these

means may be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

Detection and compensation method for monitoring the place of activity on the body

FIELD OF THE INVENTION

The invention relates to a measuring system comprising

- a sensor arranged to be attached to a subject for obtaining a measured value representing a physical or a physiological quantity of the subject, and

- means for deriving a subject-related value from the measured value.

The invention also relates to a system for determining the calorie balance of a subject, and to a method of estimating a subject-related derived value.

BACKGROUND OF THE INVENTION

Overweight and obesity are growing problems; for example over 60% of the American population can be classified as overweight or obese. Weight gain occurs when a human has a higher energy intake (food) than energy expenditure (resting metabolic rate + activity). Since this unbalance causes the weight gain problem, many weight loss programs require that users log the food consumed and activities done in order to estimate the calorie balance.

Tables and equations exist for converting nutrition values and activities into calorie intake and expenditure, respectively. However, manual calorie counting is a cumbersome process requiring knowledge, time, effort, recording and discipline. Thus, calorie logging is a problem for many people and hence it is a challenge for researchers to find a solution therefore.

In US patent application publication US2003/0065257, a combination of a diet and activity-monitoring device is described for monitoring both the consumption and activity of the subject. Such a monitoring device includes a body activity monitor for monitoring the body activity of the subject. The body activity monitor is operable to output a signal indicative of the subject's body activity. An activity calculator may also be provided, which receives the activity indicative signal and determines body activity level and/or energy expenditure for the subject. The monitoring device may take the form of a wristwatch-style device or a belt or clothing-mounted monitor. The monitoring device may comprise a heart rate monitor. The heart rate of the subject increases with activity and decreases when the

subject is resting. The activity monitor may be calibrated using an indirect calorimeter. The heart rate sensor may be part of the wristwatch-style activity monitor, or it may be provided as a separate unit, for example in the form of a chest-strap, which communicates with the activity monitor.

The activity monitor may alternatively comprise a motion sensor such as a mechanical pendulum or a single or multi-axis accelerometer. An accelerometer is preferred since it may provide information on body movement as well as the direction and intensity of the movement. The motion sensor may form part of the wristwatch or belt or clothing-mounted monitoring device or may be part of a separate accessory that communicates with the monitoring device. The body activity monitor may be calibrated to determine activity-related energy expenditure using an indirect calorimeter.

As another alternative, the body activity monitor may include multiple modes for recording a variety of activities, such as swimming, biking, and use of stationary exercise equipment. The subject presses a start button and the body activity monitor will record the duration of the activity.

Furthermore, the monitoring device also preferably includes a consumption notation control for use by the subject to indicate when the subject consumes food. The body activity monitor and the consumption notation control may take a variety of forms. It may include a GPS antenna to determine the position of the subject using GPS signals. It may combine a time-indicative signal with the GPS signals to determine changes in position of the subject as well as the rate of change in position. This allows determination of movement or body activity. The device may be calibrated to determine caloric expenditure from the measured body activity.

Moreover, a position and/or activity discriminator may be included in or communicating with the body activity monitor. The discriminator functions to determine the position and/or activity of the subject by determining the proximity of the subject to various devices and locations, such as exercise equipment and buildings. For example, it may be determined that the subject is close to running shoes to discriminate the activity of running. In a more advanced configuration, proximity to running shoes may be combined with GPS signals, heart rate sensor and/or motion sensor output to allow the activity calculator to determine the type of activity being performed, the duration of the activity, and the intensity of the activity.

When the user uses the system for the first time, he or she may designate certain movement patterns as correlating with certain activities. This will aid to calibrate the activity monitor.

Each of the described activity monitors and sensors is designed to be placed on a single position on the body. Bodily signals such as acceleration and ECG signals, are measured local to the position where the sensor is attached to the object. For example, acceleration measured by an accelerometer on the wrist includes motion of the arm, which is not detected by an accelerometer mounted on the waist.

The existing activity monitors, including for example a wrist strap or a waist belt, are often designed to be worn on one place on the body. The existing activity monitor is calibrated such that it provides accurate results if it is attached at a predefined location on the body. If the activity monitor is attached at a different location, the measured activity may be less accurate. If the activity monitor is not attached at the reference position, errors exceeding 5% in the estimation of energy expenditure may occur. This amounts to an error exceeding approximately 100 kilocalories per day.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a measuring system that yields a more accurate estimate of a parameter relating to a subject.

According to the invention, this object is achieved in that

- the sensor is arranged to be attached at one of a plurality of positions on the subject,

- the measuring system further comprises means for determining the position of the sensor on the subject by analyzing a signal from the sensor for features that are position dependent, and

- the means for deriving the subject-related value is arranged for deriving the subject-related value also in dependence on the position of the sensor on the subject.

With these provisions, the accuracy of the derived value is guaranteed for any of a plurality of positions on the body. The subject may attach the sensor at any preferred position on the body, and can preferably attach it at a different position whenever he or she desires to do so.

Subjects may have different preferences where they prefer wearing the sensor, and the same subject may prefer wearing the sensor at different locations, depending on for example the location of the subject, the local weather, or the activity the subject is

performing at any given time. Advantageously, a plurality of sensors are attached at different positions on the subject and the means for deriving the subject-related value is arranged for combining the respective obtained measured values in order to increase the accuracy of the derived value.

It is noted that US 5 111 826 discloses a blood pressure sensor that is worn on one's fingertip and that has a hand position sensor. The hand position sensor measures the difference in height between the hand and the heart to correct the readings from the blood pressure sensor for hand-to-heart differences, whichdifferences directly correspond to differences between finger and heart blood pressure. Document EP 1 254 629 discloses an electronic sphygmomanometer for measuring blood pressure that is worn on one's wrist and has gravitational acceleration sensors to determine altitude differences between the heart and the pressure reference position of the sphygmomanometer for correcting a blood pressure value.

The invention is particularly suitable for determining a derived value relating to a human or an animal.

According to an aspect of the invention, the plurality of positions includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head. This allows for an especially flexible use of the activity monitor, because the positions mentioned are especially well suited for measuring the activity of the subject, and they are particularly convenient for wearing a sensor device.

According to another aspect of the invention, the derived value comprises an activity parameter of the subject. With this aspect, the measuring system becomes an activity monitor that enables to monitor the degree of activity performed by the subject. Other possible derived values include a temperature value or an ECG value that is automatically compensated for by the location of the sensor. Advantageously, the position of the sensor on the subject is established in dependence on an accelerometer measurement and a temperature or ECG value is compensated for in dependence on the established position.

According to an aspect of the invention, the activity parameter comprises energy expenditure. This makes the activity monitor particularly suitable for use in weight management.

According to another aspect of the invention, the activity parameter represents the degree of activity of the body part the sensor is attached to. When the position of the sensor on the subject is known, it becomes possible to monitor activity parameters related to a specific body part. For example, if the sensor is attached to the arm, the activity monitor

can track energy expenditure, and in addition can track local acceleration of the arm. For example, with additional information provided by fitness equipment, the forces applied to the arm can be estimated and combined with acceleration information provided by the sensor to obtain local energy expenditure. This enables subjects to optimize a training schedule to train a specific body part. Also, if a predefined safety limit is exceeded, this can be provided as feedback to the user to avoid potentially dangerous situations.

According to an aspect of the invention, the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration. These examples of measured values are correlated with activity.

According to another aspect of the invention, the system further comprises means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on the position of the sensor on the subject, and the sensor is arranged for generating a further measured value for each quantity in the selected subset. The subset may contain zero or more further physical and/or physiological quantities of the subject, for example temperature, ECG, or acceleration. This aspect allows the system to generate measurements that are particularly relevant to the body part the sensor is attached to. For example, a temperature measurement may provide relevant information when the temperature sensor is attached to the trunk of the body, and not when it is attached to, for example, an ankle. The system can take this into account for example by disregarding, or compensating, temperature measurement if the sensor is attached to an ankle. Further physical and/or physiological quantities, such as heart rate or temperature, can be used alongside for example a derived activity parameter in various health applications.

According to another aspect of the invention, the system further comprises

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

This aspect allows the measuring system to accurately measure, for example, an activity parameter with the sensor at one of a plurality of positions on the subject, even if the measuring system is calibrated for only a single reference position, because the deviation of the measured value caused by wearing the activity monitor at a different position is compensated for. The accuracy may be increased even further by calibrating a plurality of reference positions. In case a plurality of reference positions is calibrated, and the sensor is attached at a position that is not a reference position, the means for converting can

compensate the measured value with respect to the nearest reference position or with respect to a weighted average of reference positions, thereby increasing the accuracy further.

According to another aspect of the invention, it further comprises means for obtaining from the sensor a plurality of measured values measured during a time interval, and wherein the means for determining the position of the sensor on the subject is arranged for determining the position in dependence on the measured values measured during the time interval. This allows the position of the sensor to be determined in an especially reliable manner.

According to another aspect of the invention, the means for determining the position of the sensor on the subject is arranged for determining the position on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively. A set of rules, preferably part of a rule-based system, possibly making use of fuzzy logic, is particularly suited for determining the position of the sensor.

According to another aspect of the invention, the means for determining the position of the sensor on the subject comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval. A pattern recognition means is especially favorable to achieve a high reliability in establishing the position of the sensor on the subject.

According to an aspect of the invention, it further comprises means for determining that the user is performing a standardized activity, and the means for determining the position of the sensor on the subject is arranged for using at least one measured value obtained from the sensor, the measured value relating to a time the user is performing the standardized activity. This allows the activity monitor to determine the position of the device on the body with greater certainty. Preferably, the standardized activity has a repetition pattern with a cycle time of, for example, 1 to 2 seconds and the standardized activity is performed for at least five cycles.

According to another aspect of the invention, the means for establishing that the user is performing a standardized activity is arranged for establishing the activity in dependence on at least one measured value. This increases the accuracy and reduces the amount of required user interaction.

Another aspect of the invention further comprises a user interface for receiving input from a user for indicating when the subject is performing the standardized activity. This allows a very economical implementation of the activity monitor.

Another aspect of the invention further comprises a user interface for receiving input from a user related to the position of the sensor on the subject. This allows a very economical implementation of the activity monitor.

Another aspect of the invention further comprises

- means for establishing that the subject is performing a predetermined activity,

- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,

- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and

- means for providing feedback in dependence on the similarity measure.

If the sensor position and the type of activity are known, the actual body movements can be compared to movements that are "optimal" for that particular activity. This translates into a measure of efficiency and proficiency in the selected activity. For example, inexperienced runners have a larger vertical acceleration component than experienced runners. Optimal movement patterns can be looked up in a database with key (desired activity, body part), and a pattern-matching technique can be used to determine how the actual pattern compares to the optimal pattern. Moreover, suggestions to change movement patterns of the specific body part can be given, such as for example, "when striking a ball with a racket, try to move in a continuous circular motion, and do not stop the motion after impact, to maximize acceleration of the ball upon impact". Alternatively, movements associated with health problems such as a baseball-arm, can be detected and feedback can be provided about the undesired movements.

According to another aspect of the invention, the means for establishing that the subject is performing the predetermined activity is arranged for establishing that the subject is performing at least one of a predetermined number of predetermined activities. This allows the activity monitor to distinguish between a plurality of activities of the subject, so that feedback can be provided in relation to the established activity.

According to another aspect of the invention, it further comprises a further sensor arranged to be attached to the subject for obtaining a further measured value representing a further physical or physiological quantity of the subject, and wherein the means for deriving the subject-related value is arranged for deriving the measured value also in dependence on the further measured value. Advantageously, a plurality of sensors are attached at different positions on the subject and the means for deriving the subject-related

value is arranged for combining the respective obtained measured values in order to increase the accuracy of the derived value. Advantageously, the sensors communicate with each other or with a central unit, for example by means of a wireless or wired connection, for coordinated processing of the obtained measured values.

The system for determining the calorie balance of a subject according to the invention is characterized in that it comprises the activity monitor set forth, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure. This system can provide accurate calorie balance because the activity parameter is determined with a high degree of accuracy.

The method according to the invention is characterized in that

- the method further comprises the step of determining the position of the sensor on the subject by analyzing a signal from the sensor for features that are position dependent, and

- the step of deriving the subject-related value is performed also in dependence on the position of the sensor on the subject.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the method of the invention will be further elucidated and described with reference to the drawing, in which:

Figs. 1 A,B,C,D show sketches of a device with attachment means that can be attached at several positions on a subject.

Fig. 2 shows an activity monitor with user interface.

Fig. 3 shows an activity monitor comprising a device with a sensor connected to a separate unit by means of a wireless link.

Fig. 4 shows a diagram of an embodiment of the method according to the invention.

Figs. 5 A,B show diagrams of embodiments of the measuring method according to the invention including the compensation method according to the invention.

Fig. 6 shows a diagram of an embodiment of the method according to the invention including the method according to the invention to determine the position of the sensor on the subject.

Fig. 7 shows a diagram of an embodiment of the method according to the invention including the compensation initialization method according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1A shows an activity monitor 1 comprising a sensor 6 (shown in dotted lines), a display 10, and strap attachment means 5. The activity monitor 1 further comprises a microprocessor (not shown) for computing and displaying an activity parameter. The sensor 6 can comprise a single-axial or multi-axial accelerometer, a temperature sensor, an electrical sensor for measuring electrical body signals such as the ECG signal, a heart rate sensor, a pedometer, a global or local positioning system, or any other type of sensor. Such sensors are known to the skilled artisan. Figure 1B shows the activity monitor 1, fixed to a short strap 2 with a buckle 4, and Figure 1C shows the activity monitor 1 fixed to a long strap 3. The short strap 2 is suitable for attaching the activity monitor to a wrist or ankle, while the long strap 3 is suitable for attaching the activity monitor to a waist or chest. Figure 1D shows a side view of the activity monitor illustrating a clip 9 fixed to the back of the activity monitor, making it possible to attach the activity monitor to clothing. The activity monitor with accessories as shown can be attached at one of a plurality of positions on a subject. The display 10 can be a touch-screen display for having a subject provide input to the activity monitor.

Figure 2 shows an activity monitor 20 with at least one button 21,22, a display 23, and a sensor 24. The button can be used for receiving input from a user. Preferably, more buttons are provided to make it easier for the subject to provide different kinds of input to the activity monitor.

Figure 3 shows an activity monitor comprising a device 30 with a sensor 33. The device 30 does not have any buttons or display. The device 30 has means to communicate with a separate unit 31, preferably using a wireless link 32 such as WIFI or Bluetooth. The separate unit 31 is used to control the device 30. The separate unit 31, for example a personal computer or a personal digital assistant, comprises a microprocessor (not shown) for processing the information gathered by the device 30 by means of sensor 33. The separate unit 31 further comprises means for receiving user input and communicating the processed information to a user.

Figure 4 shows an embodiment of the method according to the invention for activity monitoring applicable to the case where the sensor 6 is attached at a reference position. In step 100, the sensor 6 delivers a measurement value at the reference position. Preferably, the sensor 6 is a tri-axial accelerometer, and the measurement value is a triple containing acceleration information in X, Y, and Z-direction. In step 101, the activity monitor computes the corresponding activity parameter, for example energy expenditure. For a tri-axial accelerometer attached to the back of the waist, a method to compute the corresponding

energy expenditure is disclosed in "Daily physical activity, energy expenditure and physical fitness; assessment and implications" by Guy Plasqui, Ph.D. thesis, Maastricht University, 2004, referred to hereinafter as "Plasqui". The back of the waist is near the center of the body and a tri-axial accelerometer attached thereto provides a good estimation of overall movements.

Figure 5A shows an example of embodiment of the method according to the invention for activity monitoring applicable to the case where the sensor 6 is attached at a position on the subject that is not a reference position. In step 105, the sensor 6 delivers a measurement value measured at the position where the sensor is attached. After this, in step 106, the measurement value is compensated for the difference of the value at the position the sensor 6 is attached and the corresponding value at the reference position. After this, in step 108, the activity parameter, in this case energy expenditure, is computed using the method of computing the corresponding energy expenditure disclosed in Plasqui. The compensation method of step 106, in a very simple version, in this embodiment can be expressed as:

$$x_{corrected} = b + x_{raw},$$

where x_{raw} represents the measured value at the position where the sensor 6 is attached, $x_{corrected}$ is the corrected measured value, and a and b are compensation constants that have been stored in a compensation database 107 as part of an initialization procedure. In a multivariate system, where the measurement value comprises a tuple, for example the X, Y, and Z-components measured by a tri-axial accelerometer, the compensation method can be expressed as:

$$x_{corrected} = b_1 + x_{raw,1} + b_2 x_{raw,2} \cdots b_N x_{raw,N},$$

where $x_{raw,1} x_{raw,2} x_{raw,N}$ represent the N components of the measurement value tuple; $x_{corrected,i}$ represents the i-th component of the corrected measurement value tuple $(x_{corrected,1} x_{corrected,2} x_{corrected,N})$, and a_i and $b_{i,j}$, for $i, j = 1, 2, \ldots, N$, are compensation constants that have been stored in a compensation database 107 as part of an initialization procedure. This example of a compensation method is particularly easy to implement. Other, potentially more flexible compensation methods are easily conceivable. Such methods include higher order polynomials, generalized linear models, other statistical methods, artificial neural networks, and fuzzy logic methods.

Figure 5B shows an alternative embodiment of the method according to the invention for activity monitoring applicable to the case where the sensor 6 is attached at a

position on the subject that is not a reference position. In step 110, the sensor 6 delivers a measurement value measured at the position where it is attached. After this, in step 111, the activity parameter, in this case energy expenditure, is computed using the method of computing the corresponding energy expenditure disclosed in Plasqui. Finally, in step 112 the computed energy expenditure is compensated for the difference of the energy expenditure as computed from the value measured at the position where the sensor 6 is attached and the "real" energy expenditure that would have been obtained if the sensor had been attached at the reference position. The compensation method, which is similar to the compensation method appearing in the embodiment according to Figure 5A, makes use of the information stored in the compensation database 113.

Figure 6 shows a diagram of an embodiment of a method of determining the position on the subject where the sensor 6 is attached and of computing the activity parameter, regardless of where the sensor was attached. In step 115, the measured value or a sequence of measured values is obtained from the sensor 6. Next, the position on the body is determined in step 116, using information from a feature database 117. To determine the position of the sensor 6 on the body, the signal from the sensor is analyzed for features that are position-dependent. Also, the subject is instructed to perform predefined standardized activities, such as walking, sitting, and standing, preferably for about 20 seconds each. Alternatively, the user can provide the activity monitor with input to indicate when he or she performs a standardized activity, and possibly, which standardized activity he or she performs. Combinations of the values during the standardized activities or the absolute measured values are used to determine the position of the sensor 6 on the subject. Thereto, a number of predefined rules are used. These rules can be in the form of "if…then" rules. An example of such a rule is: "if the measured value during walking is in the range of *A* to *B* times higher than during sitting, the sensor 6 is positioned on the lower arm", where *A* and *B* are constants stored in the feature database 117. Another example of such a rule is: "if the measured value during walking is in the range of *C* to *D*, the sensor 6 is positioned on the leg", where *C* and *D* are constants stored in the feature database 117. The rules can also be implemented in terms of fuzzy logic rules. Other ways to provide a set of rules, including for example neural network methods and logic programming, are obvious to the skilled artisan. In a preferred embodiment, the position of the sensor 6 on the subject is determined by means of pattern recognition. The pattern recognition can be performed for example by correlating a signal obtained from the sensor with a signal stored in the feature database 117. The pattern recognition can be performed in the time domain, the frequency domain, or another domain,

preferably a time-frequency domain such as a wavelet domain. Pattern recognition can be performed in many ways known to the skilled artisan. For example, techniques used in speech recognition can be applied.

After the position of the sensor 6 on the subject has been determined in step 116, and the position is not a reference position (step 118, branch 122), in step 119 the measured value is compensated for by the difference between the value at the position at which the sensor is attached and the corresponding value at a reference position, making use of the information in a compensation database 120, in a way similar to the embodiment according to Figure 5A. Finally, in step 121 the activity parameter is computed from the, possibly compensated, measured value, in a way similar to the embodiment according to Figure 5.

In another embodiment, the measured value is first converted to an activity parameter, and the activity parameter is used to determine the position of the sensor 6 on the subject in a way similar to what is described above. In that case, after the position has been determined, the computed activity parameter is compensated for the difference between the computed activity parameter and the corresponding activity parameter computed from a value measured at a reference position, while information stored in a compensation database is made use of in a way similar to the embodiment according to Figure 5B. It is also possible to use other quantities relating to measured values obtained from the sensor 6, in the step to determine the position 116 and/or in the step to compensate for the difference 119.

Figure 7 shows a diagram of an embodiment of an initialization procedure for the compensation database. In this embodiment, a sequence of steps is performed iteratively. As a first step 130, *i* and *j* are both initialized to 1. Each iteration starts with step 131 comprising an instruction to the subject to perform predefined activity *i*. The instruction can comprise a spoken instruction to walk, sit, or stand, or it can for example comprise showing the activity on a display for a predefined duration. Then, in step 132 the subject performs the predefined activity *i*, while the sensor 6 attached at position *j* on the subject measures a physical value, in this case tri-axial acceleration, in step 133. Next, in step 134 the essential features are extracted from the measured value signal and stored in a feature database 135. These essential features may comprise decision rules or constants that are part of decision rules, similar to the constants *A*, *B*, *C*, and *D* appearing in the description of the embodiment according to Figure 6. Similarly, essential signal patterns can be stored in the time domain, frequency domain, time-frequency domain, or any other domain or combination of domains. Simultaneously, if position *j* is not a reference position (step 136, branch 145), in step 137

compensation parameters describing the difference between the measured value at the position of the sensor 6 on the subject and the corresponding value at a reference position are determined and stored in a compensation database 138. These compensation parameters may comprise constants appearing in the compensation method, similar to the constants a, b, a_i, and $b_{i,j}$ occurring in the description of the embodiment according to Figure 5A.

To conclude an iteration, i is increased in step 139, and if i is smaller than or equal to the number of predefined activities (step 140, branch 147), the iteration steps are repeated; otherwise, j is increased in step 141, and if j is smaller than or equal to the predefined number of positions (step 142, branch 148), i is set to 1 in step 143 and the iteration steps are repeated. If j is greater than the predefined number of positions (step 142, branch 149), the initialization procedure is finished.

In general, this sequence could be paralleled further, for example by using a plurality of sensors 6 to measure the value at a plurality of positions on the subject simultaneously. In this embodiment, the steps of extracting compensation parameters and extracting essential signal features are performed in parallel. However, they can also be performed sequentially. In an alternative embodiment, the activity parameter is computed after the sensor 6 has delivered the signal in step 133, and before extracting essential features in step 134 and determining compensation parameters in step 137. It is also possible to compute at least one derived quantity from the values measured by the sensor 6, and perform the steps of extracting essential features and determining compensation parameters based on the derived quantity.

In another embodiment, the initialization of the compensation database and the feature database are performed on the basis of a population of subjects. All subjects are asked to perform the standardized activities, the measured values are obtained from the sensor 6 at multiple positions on the subject, and after the data of all subjects have been collected and stored in an intermediate database, the compensation database and the feature database are filled with values that are representative of the population. This embodiment has the advantage that the activity monitor needs to be initialized only once, possibly by the manufacturer, and after that an unlimited number of activity monitors can be produced using the same database values.

It will be appreciated that the invention also extends to computer programs, particularly computer programs on or in a carrier, adapted for putting the invention into practice. The program may be in the form of source code, object code, a code intermediate

source and object code such as partially compiled form, or in any other form suitable for use in the implementation of the method according to the invention. The carrier may be any entity or device capable of carrying the program. For example, the carrier may include a storage medium, such as a ROM, for example a CD ROM or a semiconductor ROM, or a magnetic recording medium, for example a floppy disc or hard disk. Further, the carrier may be a transmissible carrier such as an electrical or optical signal, which may be conveyed via electrical or optical cable or by radio or other means. When the program is embodied in such a signal, the carrier may be constituted by such cable or other device or means. Alternatively, the carrier may be an integrated circuit in which the program is embedded, the integrated circuit being adapted for performing, or for use in the performance of, the relevant method.

A measuring system comprises a sensor arranged to be attached to a subject for obtaining a measured value representing a physical or a physiological quantity of the subject. The measuring system further comprises means for deriving a subject-related value from the measured value. The sensor is arranged to be attached at one of a plurality of positions on the subject. The measuring system further comprises means for establishing the position of the sensor on the subject. The means for deriving the subject-related value is arranged for deriving the subject-related value also in dependence on the position of the sensor on the subject.

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. Use of the verb "to comprise" and its conjugations does not exclude the presence of elements or steps other than those stated in a claim. The article "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. The invention may be implemented by means of hardware comprising several distinct elements, and by means of a suitably programmed computer. In the device claim enumerating several means, several of these means may be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

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Letter accompanying subsequently filed items

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The document(s) listed below is (are) subsequently filed documents pertaining to the following application:

Application number	06832085.2
Applicant's or representative's reference	PH003603EP2

	Description of document	Original file name	Assigned file name
1	Reply to examination report	PH003603.EP2.pdf	EXRE3-1.pdf
2	Amended claims	PH003603EP2.cl.pdf	CLMSPAMD-1.pdf
3	Amended claims	PH003603EP2.cl-tr.pdf	CLMSPAMD-2.pdf
4	Amended description	PH003603EP2.des.pdf	DESCPAMD-1.pdf
5	Amended description	PH003603EP2.des-tr.pdf	DESCPAMD-2.pdf

	Payment	
1	Mode of payment	Not specified

Annotations

Signatures

Place:	**Eindhoven**
Date:	**27 January 2010**
Signed by:	**NL, Philips IP&S, H. Schmitz 1176**
Capacity:	**(Koninklijke Philips Electronics N.V.)**

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Ref: PH003603 EP2
FREE/LD
Date: 2010-01-27

Re: **European Patent Application No. 06 832 085.2-1526**
Applicant: Koninklijke Philips Electronics N.V.

In response to the Communication pursuant to Article 94(3) EPC dated 19.08.2009 a new set a claims and replacement pages for the description are submitted.

Amendments

Reference is made to the PCT publication of this application.
New claim 1 is based on the page 11 lines 10 to 15 stating that to determine the position of the sensor on the body the signal from the sensor is analyzed for features that are position dependent. New claim 1 is also supported by claim 9 presently on file defining that the means for determining the position of the sensor on the subject is arranged for performing the determining in dependence on the measure value.
New claim 3 is based on the subject matter of claims 3 and 4.
New claim 15 has been amended to bring it into conformity with new claim 1.
Pages 3, 4, 6 and 8 have been amended to reflect the amendments in the claims.

Novelty

New claim 1 defines a measuring system comprising a sensor for obtaining a measured value representing a physical quantity of a subject. With the measured value and dependent on the position of the sensor a subject related value is derived. The signal of said sensor is also used to determine the position of said sensor on the subject. This is done by analyzing the signal for features that are position dependent.
D1 (US5,111,826) discloses a method of determining the absolute blood pressure. In the method various sensors are used, see claim 1. A piezo electric pressure transducer is clamped onto a finger. An ultrasonic hand position / height sensor produces a pressure signal to the hand and heart levels, see claim. This pressure signal obtained with the position / height sensor is used for correction, see last step of method claim 1 and column 4, lines 42 – 50.
D1 does not disclose that by analyzing the signal of the piezo electric transducer the position of said sensor is determined. D1 discloses that the signal of another sensor, the position / height sensor, is used to determine the hand position (difference in height

between the hand and the heart, column 3 lines 43, 44). D1 does not disclose that the signal of the piezo electric transducer is analyzed for features that are position dependent.
Hence claim 1 is novel in view of D2.
D2 (EP 1 254 629A1) discloses an electric sphygmanometer comprising measuring means placed on a predetermined region and measures blood pressure and posture detecting means for detecting a posture of a person, see claim 1. The blood pressure is determined using a pressure sensor for detecting an air pressure in the cuff, see [0021]. The posture detecting means has an angle detector 11 [0021] or gravitational acceleration sensors [0055].
D2 does not disclose that by analyzing the signal of the pressure sensor in the cuff the position of said sensor is determined. D2 discloses that the signal of another sensor, for example the acceleration sensor, is used to determine an altitude difference between the heart and the reference position, see [0056]. D2 does not disclose that the signal of the pressure sensor is analyzed for features that are position dependent.
Hence claim 1 is novel in view of D2.

Inventive step

D1 discloses a method for determining blood pressure, which is also a measured value representing a physical quantity of a subject. D1 is regarded to be in the same field as the invention and is assumed to be the closest prior art.
The distinguishing feature of the invention is defined in the characterizing portion of new claim 1.
This feature provides the effect that regardless of where the sensor for obtaining a measured value representing a physical quantity was attached to the subject its position may be determined, enabling the measuring system to yield a more accurate estimation of a parameter relating to the subject (pg 3 lines 18, 19).
The objective technical problem is to obtain a more accurate estimation of a measured value representing a physical quantity of a subject using a sensor that may be attached to a plurality of positions on said subject.
D1 discloses a method to enhance the accuracy of the measurement by including a correction based on signals obtained from another sensor i.e. the hand position /height sensor. Thus D1 teaches away from using the signal of the sensor itself and analyze is for features that are position dependent. Instead it suggests to add a hand position sensor and use the output signal from that sensor to correct the measurement value obtained from the piezoelectric pressure sensor.
Even if the skilled person would consult D2 he would find there a confirmation of the teaching of D1. Also in D2 it is suggested to use additional sensors to obtain data on relative positions of body parts that can be used to enhance the accuracy of the blood pressure sensor.
In view of the aforementioned considerations it is submitted that new claim 1 is also inventive over D1 and D2.

It is hoped that the Examiner will consider the present application to be in order for acceptance, but if that is not the case and the Examiner is unwilling to offer us an opportunity for a further written submission or a less formal discussion of the outstanding

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problems before issuance of any final rejection, we respectfully request oral proceedings in accordance with EPC Article 116.
It should be noted that insofar as any subject-matter might otherwise be regarded as having been abandoned or effectively disclaimed by virtue of amendments mentioned above and/or incorporated in the new pages submitted with this letter, the applicants wish to reserve the right to restore such subject-matter and/or file a divisional application in respect thereof.
Any amendments made by way of the present letter, and the observations contained herein, are made solely for the purposes of the prosecution of this European patent application and without prejudice to the application in other jurisdictions.

The Professional Representative,

H.J.R. Schmitz

Encl.: - amended set of claims
- amended description

The examination is being carried out on the **following application documents**:

Description, Pages

1-15	received on	15.07.2008	with letter of	15.07.2008

Claims, Numbers

1-15	received on	15.07.2008	with letter of	15.07.2008

Drawings, Sheets

1/5-5/5	as published

1. Claim 1 introduces subject-matter which extends beyond the content of the application as filed, contrary to Article 123(2) EPC. The amendment concerned is the following: "from said plurality of positions". The passage cited by the applicant as a basis for the amendment does not disclose this feature. The feature in the claim could give the impression that establishing the position is based on the plurality of positions. The passage does not at all provide a basis for this interpretation. No literal or other basis in the passages cited by the applicant or anywhere else in the entire application as filed could be found. Alternatively, the feature gives the impression that there is potential list of a limited number of predefined positions, and it is determined at which one of these limited positions the sensor is placed. However, this is also not clearly and unambiguously described by the passage referred to by the applicant. No literal or other basis in the passages cited by the applicant or anywhere else in the entire application as filed could be found for this interpretation. Since the claims now seems to cover both of these interpretations, and since there is not a basis for both interpretations, claim 1 introduces added matter.

2. A Written Opinion of the ISA has already been drawn up for the present application in accordance with the PCT. The deficiencies mentioned in that report give rise to objections under the corresponding provisions of the EPC, in particular:

   - lack of novelty (Art. 52(1), 54(1) and (2) EPC)
   - lack of inventive step (Art. 52(1) and 56 EPC)

3. With respect to applicant's arguments, it is noted that it is not relevant that D1 and D2 possibly only describe the sensor at one fixed position, it can certainly be affixed at a plurality of positions. The positions are not part of the claimed system, nor is a potential list of predefined positions.

   The features of D1 described in applicant's letter dated 15.07.2008, p. 2, par. 3, clearly describe a position measurement. It is not stated in claim 1 that there needs to be determined a position comprising three coordinates, for example. The same applies to the comments with respect to D2 in the next paragraph of applicant's letter.

4. It is not at present apparent which part of the application could serve as a basis for a new, allowable claim. Should the applicant nevertheless regard some particular matter as patentable, an independent claim should be filed taking account of Rule 43(1) EPC. The applicant should also indicate in the letter of reply the difference of the subject-matter of the new claim vis-à-vis the state of the art and the significance thereof. When new effects in support of inventive step are referred to, they must be at least related to the technical problem initially suggested in the application as filed (Guidelines C-IV 11.10).

   Amended claims may not relate to unsearched subject-matter which does not combine with the originally claimed invention to form a single general inventive concept (Rule 137(4) EPC).

5. The applicant is requested to bring the description, in particular the statement of invention, into conformity with amended claims, Rule 42(1)(c) and Art. 84 EPC.

6. The applicant is requested to effect the amendments by filing replacement pages for only those pages which have been amended. Unnecessary recasting of the description should be avoided. In order to facilitate the examination of the

conformity of the amended application with the requirements of Article 123(2) EPC, the applicant is requested to clearly identify the amendments carried out, irrespective of whether they concern amendments by addition, replacement or deletion, and to ***indicate the passages of the application as filed on which these amendments are based*** (Guidelines E-II 1).

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Application No.	Ref.	Date
06 832 085.2 - 1526	PH003603EP2	19.08.2009
Applicant: Koninklijke Philips Electronics N.V.		

Communication pursuant to Article 94(3) EPC

The examination of the above-identified application has revealed that it does not meet the requirements of the European Patent Convention for the reasons enclosed herewith. If the deficiencies indicated are not rectified the application may be refused pursuant to Article 97(2) EPC.

You are invited to file your observations and insofar as the deficiencies are such as to be rectifiable, to correct the indicated deficiencies within a period

of 6 months

from the notification of this communication, this period being computed in accordance with Rules 126(2) and 131(2) and (4) EPC. One set of amendments to the description, claims and drawings is to be filed within the said period on separate sheets (R. 50(1) EPC).

Failure to comply with this invitation in due time will result in the application being deemed to be withdrawn (Art. 94(4) EPC).

Clevorn, Jens
Primary Examiner
For the Examining Division

Enclosure(s): 3 page/s reasons (Form 2906)

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Date
06.08.08

Reference	Application No./Patent No.
PH003603EP2	06832085.2 - 1526 / 1962670 PCT/IB2006054599

Applicant/Proprietor
Koninklijke Philips Electronics N.V.

Communication of European publication number and information on the application of Article 67(3) EPC

The provisional protection under Article 67(1) and (2) EPC in the individual Contracting States becomes effective only when the conditions referred to in Article 67(3) EPC have been fulfilled (for further details, see information brochure of the European Patent Office "National Law relating to the EPC" and additional information in the Official Journal of the European Patent Office).

Pursuant to Article 153(3) EPC the publication under Article 21 PCT of an international application for which the European Patent Office is a designated or elected Office takes the place of the publication of a European patent application.

The bibliographic data of the above-mentioned Euro-PCT application will be published on 03.09.08 in Section I.1 of the European Patent Bulletin. The European publication number is 1962670.

In all future communications to the European Patent Office, please quote the application number plus Directorate number.

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Date 30-07-2008

Reference	Application No./Patent No.
PH003603EP2	06832085.2 - 1526 PCT/IB2006054599

Applicant/Proprietor
Koninklijke Philips Electronics N.V.

Communication pursuant to Rules 161 and 162 EPC

(1) Amendment of application documents, especially the claims (R. 161 EPC)

The above mentioned international (Euro-PCT) application has entered the European phase.

Under Articles 28, 41 PCT, Rules 52, 78 PCT and Rule 137(2) to (4) EPC, the applicant may amend the application documents after receiving the international search report.

Whether or not he has already done so, he now has a further opportunity to file amended claims or other application documents within a non-extendable period of ONE MONTH after notification of the present communication (R. 161 EPC).

The claims applicable on expiry of the above time limit, i.e. those filed on entry into the European phase or in response to the present communication, will form the basis for the calculation of any claims fee to be paid (see page 2) and for any supplementary search to be carried out under Article 153(7) EPC (R. 161 EPC).

--2/

(2) Claims fees under Rule 162 EPC

If the application documents on which the European grant procedure is to be based comprise more than fifteen claims, a claims fee shall be payable for the sixteenth and each subsequent claim within the period provided for in Rule 159(1) EPC.

☑ Based on the application documents currently on file, all necessary claims fees have already been paid (or the documents do not comprise more than 15 claims).

☐ All necessary fees will be/have been debited automatically according to the automatic debit order.

☐ The claims fee due for the claims ..... to ..... were not paid within the above-mentioned period.

Any non-paid claims fee, either based on the current set of claims or on any amended claims to be filed pursuant to Rule 161 EPC (see page 1), may still be validly paid within a non-extendable period of **one month** after notification of this communication (R. 162(2) EPC).

If a payment is made for only some of the claims, it must be indicated for which claims it is intended. If a claims fee is not paid in due time, the claim concerned is deemed to be abandoned (R. 162(4) EPC).

If claims fees have already been paid, but on expiry of the above-mentioned period there is a new set of claims containing fewer fee-incurring claims than previously, the claims fees in excess of those due under Rule 162(2), 2nd sentence EPC will be refunded (R. 162(3) EPC).

You are reminded that any supplementary search under Article 153(7) EPC will relate only to the last set of claims applicable on expiry of the above period AND will be confined to those fee-incurring claims for which fees have been paid in due time.

The fee for the sixteenth and each subsequent claim is EUR 200,00.

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Acknowledgement of receipt

We hereby acknowledge receipt of the following subsequently filed document(s):

Submission number	416111	
Application number	EP06832085.2	
Date of receipt	15 July 2008	
Receiving office	European Patent Office, The Hague	
Your reference	PH003603EP2	
Applicant	All applicants as on file	
Documents submitted	package-data.xml epf1038.pdf (1 p.) DESCPAMD-1.pdf\PH003603 EP2 Amended description - track changes _15.pdf (15 p.) CLMSPAMD-1.pdf\PH003603 EP2 Amended Claims - clean _15.pdf (3 p.)	ep-sfd-request.xml ABEX-1.pdf\PH003603 EP2 brf EPO_15.pdf (3 p.) DESCPAMD-2.pdf\PH003603 EP2 Amended description - clean _15.pdf (15 p.) CLMSPAMD-2.pdf\PH003603 EP2 Amended Claims - track changes _15.pdf (4 p.)
Submitted by	CN=M. van Velzen 7752,O=Philips IP&S,C=NL	
Method of submission	Online	
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/European Patent Office/

CLAIMS:

1. A measuring system (1) comprising

- a sensor (6) arranged to be attached at one of a plurality of positions on a subject for obtaining a measured value representing a physical or a physiological quantity of the subject, and

- means for establishing the position of the sensor from said plurality of positions on the subject, and

- means for deriving a subject-related value from the measured value also in dependence on the position of the sensor on the subject.

2. The measuring system (1) according to claim 1, wherein the plurality of positions includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head.

3. The measuring system (1) according to claim 1, wherein the derived value comprises an activity parameter of the subject.

~~4. The measuring system (1) according to claim 3, wherein~~ the activity parameter ~~comprises~~ comprising energy expenditure.

~~5~~4. The measuring system (1) according to claim 1, wherein the activity parameter represents a degree of activity of the body part the sensor is attached to.

~~6~~5. The measuring system (1) according to claim 1, wherein the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration.

~~7~~6. The measuring system (1) according to claim 1, further comprising means for selecting a subset of a predefined set of further physical and/or physiological quantities of the

subject in dependence on the position of the sensor on the subject, and the sensor is arranged for generating a further measured value for each quantity in the selected subset.

~~8~~7. The measuring system (1) according to claim 1, further comprising

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

~~9~~8. The measuring system (1) according to claim 1, wherein the means for determining the position of the sensor on the subject is arranged for performing the determining in dependence on the measured value.

~~10~~9. The measuring system (1) according to claim ~~9~~8, further comprising means for obtaining from the sensor (6) a plurality of measured values measured during a time interval, and wherein the means for determining the position of the sensor on the subject is arranged for performing the determining in dependence on the measured values measured during the time interval.

~~11~~10. The measuring system (1) according to claim ~~9~~8 or ~~10~~9, wherein the means for determining the position of the sensor (6) on the subject is arranged for performing the determining on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively.

~~12~~11. The measuring system (1) according to claim ~~10~~9, wherein the means for determining the position of the sensor (6) on the subject comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval.

~~13~~12. The measuring system (1) according to claim ~~9~~8 or ~~10~~9, further comprising means for determining that the user is performing a standardized activity, and wherein the means for determining the position of the sensor on the subject is arranged for using at least one measured value obtained from the sensor (6), the measured value relating to a time the user is performing the standardized activity.

~~14. The measuring system (1) according to claim 13, wherein the means for determining that the user is performing a standardized activity is arranged for performing the determining in dependence on at least one measured value.~~

~~15. The measuring system (1) according to claim 13, further comprising a user interface for receiving input from a user to indicate when the subject is performing the standardized activity.~~

~~16~~13. The measuring system (1) according to claim 1, further comprising a user interface for receiving input from a user related to the position of the sensor on the subject.

~~17. The measuring system (1) according to claim 1, further comprising~~

~~means for establishing that the subject is performing a predetermined activity,~~

~~storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,~~

~~means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and~~

~~means for providing feedback in dependence on the similarity measure.~~

~~18. The measuring system (1) according to claim 17, wherein the means for establishing that the subject is performing the predetermined activity is arranged for establishing that the subject is performing at least one of a predetermined number of predetermined activities.~~

~~19. A measuring system (1) according to claim 1, further comprising a further sensor arranged to be attached to the subject for obtaining a further measured value representing a further physical or physiological quantity of the subject, and wherein the means for deriving the subject-related value is arranged for deriving the measured value also in dependence on the further measured value.~~

~~20~~14. A system for determining the calorie balance of a subject, the system comprising the measuring system (1) according to claim ~~43~~, means for monitoring food

consumption, and means for deriving the calorie balance using the derived energy expenditure.

~~24~~15. A method of estimating a derived value relating to a subject, the method comprising

- obtaining at least one measured value from a sensor (6) attached to the subject, the measured value representing a physical or a physiological quantity of the subject, and

- establishing the position of the sensor on the subject, and

- deriving the subject-related value from the measured value also in dependence on the position of the sensor on the subject.

CLAIMS:

1. A measuring system (1) comprising

- a sensor (6) arranged to be attached at one of a plurality of positions on a subject for obtaining a measured value representing a physical or a physiological quantity of the subject, and

- means for establishing the position of the sensor from said plurality of positions on the subject, and

- means for deriving a subject-related value from the measured value also in dependence on the position of the sensor on the subject.

2. The measuring system (1) according to claim 1, wherein the plurality of positions includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head.

3. The measuring system (1) according to claim 1, wherein the derived value comprises an activity parameter of the subject, the activity parameter comprising energy expenditure.

4. The measuring system (1) according to claim 1, wherein the activity parameter represents a degree of activity of the body part the sensor is attached to.

5. The measuring system (1) according to claim 1, wherein the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration.

6. The measuring system (1) according to claim 1, further comprising means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on the position of the sensor on the subject, and the sensor is arranged for generating a further measured value for each quantity in the selected subset.

7. The measuring system (1) according to claim 1, further comprising

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

8. The measuring system (1) according to claim 1, wherein the means for determining the position of the sensor on the subject is arranged for performing the determining in dependence on the measured value.

9. The measuring system (1) according to claim 8, further comprising means for obtaining from the sensor (6) a plurality of measured values measured during a time interval, and wherein the means for determining the position of the sensor on the subject is arranged for performing the determining in dependence on the measured values measured during the time interval.

10. The measuring system (1) according to claim 8 or 9, wherein the means for determining the position of the sensor (6) on the subject is arranged for performing the determining on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively.

11. The measuring system (1) according to claim 9, wherein the means for determining the position of the sensor (6) on the subject comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval.

12. The measuring system (1) according to claim 8 or 9, further comprising means for determining that the user is performing a standardized activity, and wherein the means for determining the position of the sensor on the subject is arranged for using at least one measured value obtained from the sensor (6), the measured value relating to a time the user is performing the standardized activity.

13. The measuring system (1) according to claim 1, further comprising a user interface for receiving input from a user related to the position of the sensor on the subject.

14. A system for determining the calorie balance of a subject, the system comprising the measuring system (1) according to claim 3, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure.

15. A method of estimating a derived value relating to a subject, the method comprising

- obtaining at least one measured value from a sensor (6) attached to the subject, the measured value representing a physical or a physiological quantity of the subject, and

- establishing the position of the sensor on the subject, and

- deriving the subject-related value from the measured value also in dependence on the position of the sensor on the subject.

Detection and compensation method for monitoring the place of activity on the body

FIELD OF THE INVENTION

The invention relates to a measuring system comprising

- a sensor arranged to be attached to a subject for obtaining a measured value representing a physical or a physiological quantity of the subject, and

- means for deriving a subject-related value from the measured value.

The invention also relates to a system for determining the calorie balance of a subject, and to a method of estimating a subject-related derived value.

BACKGROUND OF THE INVENTION

Overweight and obesity are growing problems; for example over 60% of the American population can be classified as overweight or obese. Weight gain occurs when a human has a higher energy intake (food) than energy expenditure (resting metabolic rate + activity). Since this unbalance causes the weight gain problem, many weight loss programs require that users log the food consumed and activities done in order to estimate the calorie balance.

Tables and equations exist for converting nutrition values and activities into calorie intake and expenditure, respectively. However, manual calorie counting is a cumbersome process requiring knowledge, time, effort, recording and discipline. Thus, calorie logging is a problem for many people and hence it is a challenge for researchers to find a solution therefore.

In US patent application publication US2003/0065257, a combination of a diet and activity-monitoring device is described for monitoring both the consumption and activity of the subject. Such a monitoring device includes a body activity monitor for monitoring the body activity of the subject. The body activity monitor is operable to output a signal indicative of the subject's body activity. An activity calculator may also be provided, which receives the activity indicative signal and determines body activity level and/or energy expenditure for the subject. The monitoring device may take the form of a wristwatch-style device or a belt or clothing-mounted monitor. The monitoring device may comprise a heart rate monitor. The heart rate of the subject increases with activity and decreases when the

subject is resting. The activity monitor may be calibrated using an indirect calorimeter. The heart rate sensor may be part of the wristwatch-style activity monitor, or it may be provided as a separate unit, for example in the form of a chest-strap, which communicates with the activity monitor.

The activity monitor may alternatively comprise a motion sensor such as a mechanical pendulum or a single or multi-axis accelerometer. An accelerometer is preferred since it may provide information on body movement as well as the direction and intensity of the movement. The motion sensor may form part of the wristwatch or belt or clothing-mounted monitoring device or may be part of a separate accessory that communicates with the monitoring device. The body activity monitor may be calibrated to determine activity-related energy expenditure using an indirect calorimeter.

As another alternative, the body activity monitor may include multiple modes for recording a variety of activities, such as swimming, biking, and use of stationary exercise equipment. The subject presses a start button and the body activity monitor will record the duration of the activity.

Furthermore, the monitoring device also preferably includes a consumption notation control for use by the subject to indicate when the subject consumes food. The body activity monitor and the consumption notation control may take a variety of forms. It may include a GPS antenna to determine the position of the subject using GPS signals. It may combine a time-indicative signal with the GPS signals to determine changes in position of the subject as well as the rate of change in position. This allows determination of movement or body activity. The device may be calibrated to determine caloric expenditure from the measured body activity.

Moreover, a position and/or activity discriminator may be included in or communicating with the body activity monitor. The discriminator functions to determine the position and/or activity of the subject by determining the proximity of the subject to various devices and locations, such as exercise equipment and buildings. For example, it may be determined that the subject is close to running shoes to discriminate the activity of running. In a more advanced configuration, proximity to running shoes may be combined with GPS signals, heart rate sensor and/or motion sensor output to allow the activity calculator to determine the type of activity being performed, the duration of the activity, and the intensity of the activity.

When the user uses the system for the first time, he or she may designate certain movement patterns as correlating with certain activities. This will aid to calibrate the activity monitor.

Each of the described activity monitors and sensors is designed to be placed on a single position on the body. Bodily signals such as acceleration and ECG signals, are measured local to the position where the sensor is attached to the object. For example, acceleration measured by an accelerometer on the wrist includes motion of the arm, which is not detected by an accelerometer mounted on the waist.

The existing activity monitors, including for example a wrist strap or a waist belt, are often designed to be worn on one place on the body. The existing activity monitor is calibrated such that it provides accurate results if it is attached at a predefined location on the body. If the activity monitor is attached at a different location, the measured activity may be less accurate. If the activity monitor is not attached at the reference position, errors exceeding 5% in the estimation of energy expenditure may occur. This amounts to an error exceeding approximately 100 kilocalories per day.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a measuring system that yields a more accurate estimate of a parameter relating to a subject.

According to the invention, this object is achieved in that

- the sensor is arranged to be attached at one of a plurality of positions on the subject,

- the measuring system further comprises means for establishing the position of the sensor from said plurality of positions on the subject, and

- the means for deriving the subject-related value is arranged for deriving the subject-related value also in dependence on the position of the sensor on the subject.

With these provisions, the accuracy of the derived value is guaranteed for any of a plurality of positions on the body. The subject may attach the sensor at any preferred position on the body, and can preferably attach it at a different position whenever he or she desires to do so.

Subjects may have different preferences where they prefer wearing the sensor, and the same subject may prefer wearing the sensor at different locations, depending on for example the location of the subject, the local weather, or the activity the subject is performing at any given time. Advantageously, a plurality of sensors are attached at different

positions on the subject and the means for deriving the subject-related value is arranged for combining the respective obtained measured values in order to increase the accuracy of the derived value.

It is noted that US 5 111 826 discloses a blood pressure sensor that is worn on one's fingertip and that has a hand position sensor. The hand position sensor measures the difference in height between the hand and the heart to correct the readings from the blood pressure sensor for hand-to-heart height differences, which differences directly correspond to the differences between finger and heart blood pressure. Document EP 1 254 629 discloses an electronic sphygmomanometer for measuring blood pressure that is worn on one's wrist and has gravitational acceleration sensors to determine altitude differences between the heart and the pressure reference position of the sphygmomanometer for correcting a blood pressure value.

The invention is particularly suitable for determining a derived value relating to a human or an animal.

According to an aspect of the invention, the plurality of positions includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head. This allows for an especially flexible use of the activity monitor, because the positions mentioned are especially well suited for measuring the activity of the subject, and they are particularly convenient for wearing a sensor device.

According to another aspect of the invention, the derived value comprises an activity parameter of the subject. With this aspect, the measuring system becomes an activity monitor that enables to monitor the degree of activity performed by the subject. Other possible derived values include a temperature value or an ECG value that is automatically compensated for by the location of the sensor. Advantageously, the position of the sensor on the subject is established in dependence on an accelerometer measurement and a temperature or ECG value is compensated for in dependence on the established position.

According to an aspect of the invention, the activity parameter comprises energy expenditure. This makes the activity monitor particularly suitable for use in weight management.

According to another aspect of the invention, the activity parameter represents the degree of activity of the body part the sensor is attached to. When the position of the sensor on the subject is known, it becomes possible to monitor activity parameters related to a specific body part. For example, if the sensor is attached to the arm, the activity monitor can track energy expenditure, and in addition can track local acceleration of the arm. For

example, with additional information provided by fitness equipment, the forces applied to the arm can be estimated and combined with acceleration information provided by the sensor to obtain local energy expenditure. This enables subjects to optimize a training schedule to train a specific body part. Also, if a predefined safety limit is exceeded, this can be provided as feedback to the user to avoid potentially dangerous situations.

According to an aspect of the invention, the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration. These examples of measured values are correlated with activity.

According to another aspect of the invention, the system further comprises means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on the position of the sensor on the subject, and the sensor is arranged for generating a further measured value for each quantity in the selected subset. The subset may contain zero or more further physical and/or physiological quantities of the subject, for example temperature, ECG, or acceleration. This aspect allows the system to generate measurements that are particularly relevant to the body part the sensor is attached to. For example, a temperature measurement may provide relevant information when the temperature sensor is attached to the trunk of the body, and not when it is attached to, for example, an ankle. The system can take this into account for example by disregarding, or compensating, temperature measurement if the sensor is attached to an ankle. Further physical and/or physiological quantities, such as heart rate or temperature, can be used alongside for example a derived activity parameter in various health applications.

According to another aspect of the invention, the system further comprises

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

This aspect allows the measuring system to accurately measure, for example, an activity parameter with the sensor at one of a plurality of positions on the subject, even if the measuring system is calibrated for only a single reference position, because the deviation of the measured value caused by wearing the activity monitor at a different position is compensated for. The accuracy may be increased even further by calibrating a plurality of reference positions. In case a plurality of reference positions is calibrated, and the sensor is attached at a position that is not a reference position, the means for converting can

compensate the measured value with respect to the nearest reference position or with respect to a weighted average of reference positions, thereby increasing the accuracy further.

Another aspect of the invention is characterized in that the means for determining the position of the sensor on the subject is arranged for determining the position in dependence on the measured value. This allows the sensor to be attached at different positions on the subject, without any additional user interaction to indicate the actual position of the device.

According to another aspect of the invention, it further comprises means for obtaining from the sensor a plurality of measured values measured during a time interval, and wherein the means for determining the position of the sensor on the subject is arranged for determining the position in dependence on the measured values measured during the time interval. This allows the position of the sensor to be determined in an especially reliable manner.

According to another aspect of the invention, the means for determining the position of the sensor on the subject is arranged for determining the position on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively. A set of rules, preferably part of a rule-based system, possibly making use of fuzzy logic, is particularly suited for determining the position of the sensor.

According to another aspect of the invention, the means for determining the position of the sensor on the subject comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval. A pattern recognition means is especially favorable to achieve a high reliability in establishing the position of the sensor on the subject.

According to an aspect of the invention, it further comprises means for determining that the user is performing a standardized activity, and the means for determining the position of the sensor on the subject is arranged for using at least one measured value obtained from the sensor, the measured value relating to a time the user is performing the standardized activity. This allows the activity monitor to determine the position of the device on the body with greater certainty. Preferably, the standardized activity has a repetition pattern with a cycle time of, for example, 1 to 2 seconds and the standardized activity is performed for at least five cycles.

According to another aspect of the invention, the means for establishing that the user is performing a standardized activity is arranged for establishing the activity in

dependence on at least one measured value. This increases the accuracy and reduces the amount of required user interaction.

Another aspect of the invention further comprises a user interface for receiving input from a user for indicating when the subject is performing the standardized activity. This allows a very economical implementation of the activity monitor.

Another aspect of the invention further comprises a user interface for receiving input from a user related to the position of the sensor on the subject. This allows a very economical implementation of the activity monitor.

Another aspect of the invention further comprises

- means for establishing that the subject is performing a predetermined activity,

- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,

- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and

- means for providing feedback in dependence on the similarity measure.

If the sensor position and the type of activity are known, the actual body movements can be compared to movements that are "optimal" for that particular activity. This translates into a measure of efficiency and proficiency in the selected activity. For example, inexperienced runners have a larger vertical acceleration component than experienced runners. Optimal movement patterns can be looked up in a database with key (desired activity, body part), and a pattern-matching technique can be used to determine how the actual pattern compares to the optimal pattern. Moreover, suggestions to change movement patterns of the specific body part can be given, such as for example, "when striking a ball with a racket, try to move in a continuous circular motion, and do not stop the motion after impact, to maximize acceleration of the ball upon impact". Alternatively, movements associated with health problems such as a baseball-arm, can be detected and feedback can be provided about the undesired movements.

According to another aspect of the invention, the means for establishing that the subject is performing the predetermined activity is arranged for establishing that the subject is performing at least one of a predetermined number of predetermined activities. This allows the activity monitor to distinguish between a plurality of activities of the subject, so that feedback can be provided in relation to the established activity.

According to another aspect of the invention, it further comprises a further sensor arranged to be attached to the subject for obtaining a further measured value representing a further physical or physiological quantity of the subject, and wherein the means for deriving the subject-related value is arranged for deriving the measured value also in dependence on the further measured value. Advantageously, a plurality of sensors are attached at different positions on the subject and the means for deriving the subject-related value is arranged for combining the respective obtained measured values in order to increase the accuracy of the derived value. Advantageously, the sensors communicate with each other or with a central unit, for example by means of a wireless or wired connection, for coordinated processing of the obtained measured values.

The system for determining the calorie balance of a subject according to the invention is characterized in that it comprises the activity monitor set forth, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure. This system can provide accurate calorie balance because the activity parameter is determined with a high degree of accuracy.

The method according to the invention is characterized in that

- the method further comprises the step of determining the position of the sensor on the subject, and

- the step of deriving the subject-related value is performed also in dependence on the position of the sensor on the subject.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the method of the invention will be further elucidated and described with reference to the drawing, in which:

Figs. 1 A,B,C,D show sketches of a device with attachment means that can be attached at several positions on a subject.

Fig. 2 shows an activity monitor with user interface.

Fig. 3 shows an activity monitor comprising a device with a sensor connected to a separate unit by means of a wireless link.

Fig. 4 shows a diagram of an embodiment of the method according to the invention.

Figs. 5 A,B show diagrams of embodiments of the measuring method according to the invention including the compensation method according to the invention.

Fig. 6 shows a diagram of an embodiment of the method according to the invention including the method according to the invention to determine the position of the sensor on the subject.

Fig. 7 shows a diagram of an embodiment of the method according to the invention including the compensation initialization method according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1A shows an activity monitor 1 comprising a sensor 6 (shown in dotted lines), a display 10, and strap attachment means 5. The activity monitor 1 further comprises a microprocessor (not shown) for computing and displaying an activity parameter. The sensor 6 can comprise a single-axial or multi-axial accelerometer, a temperature sensor, an electrical sensor for measuring electrical body signals such as the ECG signal, a heart rate sensor, a pedometer, a global or local positioning system, or any other type of sensor. Such sensors are known to the skilled artisan. Figure 1B shows the activity monitor 1, fixed to a short strap 2 with a buckle 4, and Figure 1C shows the activity monitor 1 fixed to a long strap 3. The short strap 2 is suitable for attaching the activity monitor to a wrist or ankle, while the long strap 3 is suitable for attaching the activity monitor to a waist or chest. Figure 1D shows a side view of the activity monitor illustrating a clip 9 fixed to the back of the activity monitor, making it possible to attach the activity monitor to clothing. The activity monitor with accessories as shown can be attached at one of a plurality of positions on a subject. The display 10 can be a touch-screen display for having a subject provide input to the activity monitor.

Figure 2 shows an activity monitor 20 with at least one button 21,22, a display 23, and a sensor 24. The button can be used for receiving input from a user. Preferably, more buttons are provided to make it easier for the subject to provide different kinds of input to the activity monitor.

Figure 3 shows an activity monitor comprising a device 30 with a sensor 33. The device 30 does not have any buttons or display. The device 30 has means to communicate with a separate unit 31, preferably using a wireless link 32 such as WIFI or Bluetooth. The separate unit 31 is used to control the device 30. The separate unit 31, for example a personal computer or a personal digital assistant, comprises a microprocessor (not shown) for processing the information gathered by the device 30 by means of sensor 33. The separate unit 31 further comprises means for receiving user input and communicating the processed information to a user.

Figure 4 shows an embodiment of the method according to the invention for activity monitoring applicable to the case where the sensor 6 is attached at a reference position. In step 100, the sensor 6 delivers a measurement value at the reference position. Preferably, the sensor 6 is a tri-axial accelerometer, and the measurement value is a triple containing acceleration information in X, Y, and Z-direction. In step 101, the activity monitor computes the corresponding activity parameter, for example energy expenditure. For a tri-axial accelerometer attached to the back of the waist, a method to compute the corresponding energy expenditure is disclosed in "Daily physical activity, energy expenditure and physical fitness; assessment and implications" by Guy Plasqui, Ph.D. thesis, Maastricht University, 2004, referred to hereinafter as "Plasqui". The back of the waist is near the center of the body and a tri-axial accelerometer attached thereto provides a good estimation of overall movements.

Figure 5A shows an example of embodiment of the method according to the invention for activity monitoring applicable to the case where the sensor 6 is attached at a position on the subject that is not a reference position. In step 105, the sensor 6 delivers a measurement value measured at the position where the sensor is attached. After this, in step 106, the measurement value is compensated for the difference of the value at the position the sensor 6 is attached and the corresponding value at the reference position. After this, in step 108, the activity parameter, in this case energy expenditure, is computed using the method of computing the corresponding energy expenditure disclosed in Plasqui. The compensation method of step 106, in a very simple version, in this embodiment can be expressed as:

$$x_{\text{corrected}} = a + bx_{\text{raw}},$$

where x_{raw} represents the measured value at the position where the sensor 6 is attached, $x_{\text{corrected}}$ is the corrected measured value, and a and b are compensation constants that have been stored in a compensation database 107 as part of an initialization procedure. In a multivariate system, where the measurement value comprises a tuple, for example the X, Y, and Z-components measured by a tri-axial accelerometer, the compensation method can be expressed as:

$$x_{\text{corrected},i} = a_i + b_{i,1}x_{\text{raw},1} + b_{i,2}x_{\text{raw},2} + \cdots + b_{i,N}x_{\text{raw},N},$$

where $x_{\text{raw},1}, x_{\text{raw},2}, \ldots, x_{\text{raw},N}$ represent the N components of the measurement value tuple; $x_{\text{corrected},i}$ represents the i-th component of the corrected measurement value tuple $(x_{\text{corrected},1}, x_{\text{corrected},2}, \ldots, x_{\text{corrected},N})$, and a_i and $b_{i,j}$, for $i, j = 1, 2, \ldots, N$, are compensation

constants that have been stored in a compensation database 107 as part of an initialization procedure. This example of a compensation method is particularly easy to implement. Other, potentially more flexible compensation methods are easily conceivable. Such methods include higher order polynomials, generalized linear models, other statistical methods, artificial neural networks, and fuzzy logic methods.

Figure 5B shows an alternative embodiment of the method according to the invention for activity monitoring applicable to the case where the sensor 6 is attached at a position on the subject that is not a reference position. In step 110, the sensor 6 delivers a measurement value measured at the position where it is attached. After this, in step 111, the activity parameter, in this case energy expenditure, is computed using the method of computing the corresponding energy expenditure disclosed in Plasqui. Finally, in step 112 the computed energy expenditure is compensated for the difference of the energy expenditure as computed from the value measured at the position where the sensor 6 is attached and the "real" energy expenditure that would have been obtained if the sensor had been attached at the reference position. The compensation method, which is similar to the compensation method appearing in the embodiment according to Figure 5A, makes use of the information stored in the compensation database 113.

Figure 6 shows a diagram of an embodiment of a method of determining the position on the subject where the sensor 6 is attached and of computing the activity parameter, regardless of where the sensor was attached. In step 115, the measured value or a sequence of measured values is obtained from the sensor 6. Next, the position on the body is determined in step 116, using information from a feature database 117. To determine the position of the sensor 6 on the body, the signal from the sensor is analyzed for features that are position-dependent. Also, the subject is instructed to perform predefined standardized activities, such as walking, sitting, and standing, preferably for about 20 seconds each. Alternatively, the user can provide the activity monitor with input to indicate when he or she performs a standardized activity, and possibly, which standardized activity he or she performs. Combinations of the values during the standardized activities or the absolute measured values are used to determine the position of the sensor 6 on the subject. Thereto, a number of predefined rules are used. These rules can be in the form of "if…then" rules. An example of such a rule is: "if the measured value during walking is in the range of A to B times higher than during sitting, the sensor 6 is positioned on the lower arm", where A and B are constants stored in the feature database 117. Another example of such a rule is: "if the measured value during walking is in the range of C to D, the sensor 6 is positioned on the

leg", where *C* and *D* are constants stored in the feature database 117. The rules can also be implemented in terms of fuzzy logic rules. Other ways to provide a set of rules, including for example neural network methods and logic programming, are obvious to the skilled artisan. In a preferred embodiment, the position of the sensor 6 on the subject is determined by means of pattern recognition. The pattern recognition can be performed for example by correlating a signal obtained from the sensor with a signal stored in the feature database 117. The pattern recognition can be performed in the time domain, the frequency domain, or another domain, preferably a time-frequency domain such as a wavelet domain. Pattern recognition can be performed in many ways known to the skilled artisan. For example, techniques used in speech recognition can be applied.

After the position of the sensor 6 on the subject has been determined in step 116, and the position is not a reference position (step 118, branch 122), in step 119 the measured value is compensated for by the difference between the value at the position at which the sensor is attached and the corresponding value at a reference position, making use of the information in a compensation database 120, in a way similar to the embodiment according to Figure 5A. Finally, in step 121 the activity parameter is computed from the, possibly compensated, measured value, in a way similar to the embodiment according to Figure 5.

In another embodiment, the measured value is first converted to an activity parameter, and the activity parameter is used to determine the position of the sensor 6 on the subject in a way similar to what is described above. In that case, after the position has been determined, the computed activity parameter is compensated for the difference between the computed activity parameter and the corresponding activity parameter computed from a value measured at a reference position, while information stored in a compensation database is made use of in a way similar to the embodiment according to Figure 5B. It is also possible to use other quantities relating to measured values obtained from the sensor 6, in the step to determine the position 116 and/or in the step to compensate for the difference 119.

Figure 7 shows a diagram of an embodiment of an initialization procedure for the compensation database. In this embodiment, a sequence of steps is performed iteratively. As a first step 130, *i* and *j* are both initialized to 1. Each iteration starts with step 131 comprising an instruction to the subject to perform predefined activity *i*. The instruction can comprise a spoken instruction to walk, sit, or stand, or it can for example comprise showing the activity on a display for a predefined duration. Then, in step 132 the subject performs the predefined activity *i*, while the sensor 6 attached at position *j* on the subject measures a

physical value, in this case tri-axial acceleration, in step 133. Next, in step 134 the essential features are extracted from the measured value signal and stored in a feature database 135. These essential features may comprise decision rules or constants that are part of decision rules, similar to the constants A, B, C, and D appearing in the description of the embodiment according to Figure 6. Similarly, essential signal patterns can be stored in the time domain, frequency domain, time-frequency domain, or any other domain or combination of domains. Simultaneously, if position j is not a reference position (step 136, branch 145), in step 137 compensation parameters describing the difference between the measured value at the position of the sensor 6 on the subject and the corresponding value at a reference position are determined and stored in a compensation database 138. These compensation parameters may comprise constants appearing in the compensation method, similar to the constants a, b, a_i, and $b_{i,j}$ occurring in the description of the embodiment according to Figure 5A.

To conclude an iteration, i is increased in step 139, and if i is smaller than or equal to the number of predefined activities (step 140, branch 147), the iteration steps are repeated; otherwise, j is increased in step 141, and if j is smaller than or equal to the predefined number of positions (step 142, branch 148), i is set to 1 in step 143 and the iteration steps are repeated. If j is greater than the predefined number of positions (step 142, branch 149), the initialization procedure is finished.

In general, this sequence could be paralleled further, for example by using a plurality of sensors 6 to measure the value at a plurality of positions on the subject simultaneously. In this embodiment, the steps of extracting compensation parameters and extracting essential signal features are performed in parallel. However, they can also be performed sequentially. In an alternative embodiment, the activity parameter is computed after the sensor 6 has delivered the signal in step 133, and before extracting essential features in step 134 and determining compensation parameters in step 137. It is also possible to compute at least one derived quantity from the values measured by the sensor 6, and perform the steps of extracting essential features and determining compensation parameters based on the derived quantity.

In another embodiment, the initialization of the compensation database and the feature database are performed on the basis of a population of subjects. All subjects are asked to perform the standardized activities, the measured values are obtained from the sensor 6 at multiple positions on the subject, and after the data of all subjects have been collected and stored in an intermediate database, the compensation database and the feature database are

filled with values that are representative of the population. This embodiment has the advantage that the activity monitor needs to be initialized only once, possibly by the manufacturer, and after that an unlimited number of activity monitors can be produced using the same database values.

It will be appreciated that the invention also extends to computer programs, particularly computer programs on or in a carrier, adapted for putting the invention into practice. The program may be in the form of source code, object code, a code intermediate source and object code such as partially compiled form, or in any other form suitable for use in the implementation of the method according to the invention. The carrier may be any entity or device capable of carrying the program. For example, the carrier may include a storage medium, such as a ROM, for example a CD ROM or a semiconductor ROM, or a magnetic recording medium, for example a floppy disc or hard disk. Further, the carrier may be a transmissible carrier such as an electrical or optical signal, which may be conveyed via electrical or optical cable or by radio or other means. When the program is embodied in such a signal, the carrier may be constituted by such cable or other device or means. Alternatively, the carrier may be an integrated circuit in which the program is embedded, the integrated circuit being adapted for performing, or for use in the performance of, the relevant method.

A measuring system comprises a sensor arranged to be attached to a subject for obtaining a measured value representing a physical or a physiological quantity of the subject. The measuring system further comprises means for deriving a subject-related value from the measured value. The sensor is arranged to be attached at one of a plurality of positions on the subject. The measuring system further comprises means for establishing the position of the sensor on the subject. The means for deriving the subject-related value is arranged for deriving the subject-related value also in dependence on the position of the sensor on the subject.

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. Use of the verb "to comprise" and its conjugations does not exclude the presence of elements or steps other than those stated in a claim. The article "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. The invention may be implemented by means of hardware comprising several distinct elements, and by means of a suitably programmed computer. In the device claim enumerating several means, several of these

means may be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

Detection and compensation method for monitoring the place of activity on the body

FIELD OF THE INVENTION

The invention relates to a measuring system comprising

- a sensor arranged to be attached to a subject for obtaining a measured value representing a physical or a physiological quantity of the subject, and

- means for deriving a subject-related value from the measured value.

The invention also relates to a system for determining the calorie balance of a subject, and to a method of estimating a subject-related derived value.

BACKGROUND OF THE INVENTION

Overweight and obesity are growing problems; for example over 60% of the American population can be classified as overweight or obese. Weight gain occurs when a human has a higher energy intake (food) than energy expenditure (resting metabolic rate + activity). Since this unbalance causes the weight gain problem, many weight loss programs require that users log the food consumed and activities done in order to estimate the calorie balance.

Tables and equations exist for converting nutrition values and activities into calorie intake and expenditure, respectively. However, manual calorie counting is a cumbersome process requiring knowledge, time, effort, recording and discipline. Thus, calorie logging is a problem for many people and hence it is a challenge for researchers to find a solution therefore.

In US patent application publication US2003/0065257, a combination of a diet and activity-monitoring device is described for monitoring both the consumption and activity of the subject. Such a monitoring device includes a body activity monitor for monitoring the body activity of the subject. The body activity monitor is operable to output a signal indicative of the subject's body activity. An activity calculator may also be provided, which receives the activity indicative signal and determines body activity level and/or energy expenditure for the subject. The monitoring device may take the form of a wristwatch-style device or a belt or clothing-mounted monitor. The monitoring device may comprise a heart rate monitor. The heart rate of the subject increases with activity and decreases when the

subject is resting. The activity monitor may be calibrated using an indirect calorimeter. The heart rate sensor may be part of the wristwatch-style activity monitor, or it may be provided as a separate unit, for example in the form of a chest-strap, which communicates with the activity monitor.

The activity monitor may alternatively comprise a motion sensor such as a mechanical pendulum or a single or multi-axis accelerometer. An accelerometer is preferred since it may provide information on body movement as well as the direction and intensity of the movement. The motion sensor may form part of the wristwatch or belt or clothing-mounted monitoring device or may be part of a separate accessory that communicates with the monitoring device. The body activity monitor may be calibrated to determine activity-related energy expenditure using an indirect calorimeter.

As another alternative, the body activity monitor may include multiple modes for recording a variety of activities, such as swimming, biking, and use of stationary exercise equipment. The subject presses a start button and the body activity monitor will record the duration of the activity.

Furthermore, the monitoring device also preferably includes a consumption notation control for use by the subject to indicate when the subject consumes food. The body activity monitor and the consumption notation control may take a variety of forms. It may include a GPS antenna to determine the position of the subject using GPS signals. It may combine a time-indicative signal with the GPS signals to determine changes in position of the subject as well as the rate of change in position. This allows determination of movement or body activity. The device may be calibrated to determine caloric expenditure from the measured body activity.

Moreover, a position and/or activity discriminator may be included in or communicating with the body activity monitor. The discriminator functions to determine the position and/or activity of the subject by determining the proximity of the subject to various devices and locations, such as exercise equipment and buildings. For example, it may be determined that the subject is close to running shoes to discriminate the activity of running. In a more advanced configuration, proximity to running shoes may be combined with GPS signals, heart rate sensor and/or motion sensor output to allow the activity calculator to determine the type of activity being performed, the duration of the activity, and the intensity of the activity.

When the user uses the system for the first time, he or she may designate certain movement patterns as correlating with certain activities. This will aid to calibrate the activity monitor.

Each of the described activity monitors and sensors is designed to be placed on a single position on the body. Bodily signals such as acceleration and ECG signals, are measured local to the position where the sensor is attached to the object. For example, acceleration measured by an accelerometer on the wrist includes motion of the arm, which is not detected by an accelerometer mounted on the waist.

The existing activity monitors, including for example a wrist strap or a waist belt, are often designed to be worn on one place on the body. The existing activity monitor is calibrated such that it provides accurate results if it is attached at a predefined location on the body. If the activity monitor is attached at a different location, the measured activity may be less accurate. If the activity monitor is not attached at the reference position, errors exceeding 5% in the estimation of energy expenditure may occur. This amounts to an error exceeding approximately 100 kilocalories per day.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a measuring system that yields a more accurate estimate of a parameter relating to a subject.

According to the invention, this object is achieved in that

- the sensor is arranged to be attached at one of a plurality of positions on the subject,

- the measuring system further comprises means for establishing the position of the sensor from said plurality of positions on the subject, and

- the means for deriving the subject-related value is arranged for deriving the subject-related value also in dependence on the position of the sensor on the subject.

With these provisions, the accuracy of the derived value is guaranteed for any of a plurality of positions on the body. The subject may attach the sensor at any preferred position on the body, and can preferably attach it at a different position whenever he or she desires to do so.

Subjects may have different preferences where they prefer wearing the sensor, and the same subject may prefer wearing the sensor at different locations, depending on for example the location of the subject, the local weather, or the activity the subject is performing at any given time. Advantageously, a plurality of sensors are attached at different

positions on the subject and the means for deriving the subject-related value is arranged for combining the respective obtained measured values in order to increase the accuracy of the derived value.

It is noted that US 5 111 826 discloses a blood pressure sensor that is worn on one's fingertip and that has a hand position sensor. The hand position sensor measures the difference in height between the hand and the heart to correct the readings from the blood pressure sensor for hand-to-heart height differences, which differences directly correspond to the differences between finger and heart blood pressure. Document EP 1 254 629 discloses an electronic sphygmomanometer for measuring blood pressure that is worn on one's wrist and has gravitational acceleration sensors to determine altitude differences between the heart and the pressure reference position of the sphygmomanometer for correcting a blood pressure value.

The invention is particularly suitable for determining a derived value relating to a human or an animal.

According to an aspect of the invention, the plurality of positions includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head. This allows for an especially flexible use of the activity monitor, because the positions mentioned are especially well suited for measuring the activity of the subject, and they are particularly convenient for wearing a sensor device.

According to another aspect of the invention, the derived value comprises an activity parameter of the subject. With this aspect, the measuring system becomes an activity monitor that enables to monitor the degree of activity performed by the subject. Other possible derived values include a temperature value or an ECG value that is automatically compensated for by the location of the sensor. Advantageously, the position of the sensor on the subject is established in dependence on an accelerometer measurement and a temperature or ECG value is compensated for in dependence on the established position.

According to an aspect of the invention, the activity parameter comprises energy expenditure. This makes the activity monitor particularly suitable for use in weight management.

According to another aspect of the invention, the activity parameter represents the degree of activity of the body part the sensor is attached to. When the position of the sensor on the subject is known, it becomes possible to monitor activity parameters related to a specific body part. For example, if the sensor is attached to the arm, the activity monitor can track energy expenditure, and in addition can track local acceleration of the arm. For

example, with additional information provided by fitness equipment, the forces applied to the arm can be estimated and combined with acceleration information provided by the sensor to obtain local energy expenditure. This enables subjects to optimize a training schedule to train a specific body part. Also, if a predefined safety limit is exceeded, this can be provided as feedback to the user to avoid potentially dangerous situations.

According to an aspect of the invention, the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration. These examples of measured values are correlated with activity.

According to another aspect of the invention, the system further comprises means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on the position of the sensor on the subject, and the sensor is arranged for generating a further measured value for each quantity in the selected subset. The subset may contain zero or more further physical and/or physiological quantities of the subject, for example temperature, ECG, or acceleration. This aspect allows the system to generate measurements that are particularly relevant to the body part the sensor is attached to. For example, a temperature measurement may provide relevant information when the temperature sensor is attached to the trunk of the body, and not when it is attached to, for example, an ankle. The system can take this into account for example by disregarding, or compensating, temperature measurement if the sensor is attached to an ankle. Further physical and/or physiological quantities, such as heart rate or temperature, can be used alongside for example a derived activity parameter in various health applications.

According to another aspect of the invention, the system further comprises

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

This aspect allows the measuring system to accurately measure, for example, an activity parameter with the sensor at one of a plurality of positions on the subject, even if the measuring system is calibrated for only a single reference position, because the deviation of the measured value caused by wearing the activity monitor at a different position is compensated for. The accuracy may be increased even further by calibrating a plurality of reference positions. In case a plurality of reference positions is calibrated, and the sensor is attached at a position that is not a reference position, the means for converting can

compensate the measured value with respect to the nearest reference position or with respect to a weighted average of reference positions, thereby increasing the accuracy further.

Another aspect of the invention is characterized in that the means for determining the position of the sensor on the subject is arranged for determining the position in dependence on the measured value. This allows the sensor to be attached at different positions on the subject, without any additional user interaction to indicate the actual position of the device.

According to another aspect of the invention, it further comprises means for obtaining from the sensor a plurality of measured values measured during a time interval, and wherein the means for determining the position of the sensor on the subject is arranged for determining the position in dependence on the measured values measured during the time interval. This allows the position of the sensor to be determined in an especially reliable manner.

According to another aspect of the invention, the means for determining the position of the sensor on the subject is arranged for determining the position on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively. A set of rules, preferably part of a rule-based system, possibly making use of fuzzy logic, is particularly suited for determining the position of the sensor.

According to another aspect of the invention, the means for determining the position of the sensor on the subject comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval. A pattern recognition means is especially favorable to achieve a high reliability in establishing the position of the sensor on the subject.

According to an aspect of the invention, it further comprises means for determining that the user is performing a standardized activity, and the means for determining the position of the sensor on the subject is arranged for using at least one measured value obtained from the sensor, the measured value relating to a time the user is performing the standardized activity. This allows the activity monitor to determine the position of the device on the body with greater certainty. Preferably, the standardized activity has a repetition pattern with a cycle time of, for example, 1 to 2 seconds and the standardized activity is performed for at least five cycles.

According to another aspect of the invention, the means for establishing that the user is performing a standardized activity is arranged for establishing the activity in

dependence on at least one measured value. This increases the accuracy and reduces the amount of required user interaction.

Another aspect of the invention further comprises a user interface for receiving input from a user for indicating when the subject is performing the standardized activity. This allows a very economical implementation of the activity monitor.

Another aspect of the invention further comprises a user interface for receiving input from a user related to the position of the sensor on the subject. This allows a very economical implementation of the activity monitor.

Another aspect of the invention further comprises

- means for establishing that the subject is performing a predetermined activity,
- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,
- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and
- means for providing feedback in dependence on the similarity measure.

If the sensor position and the type of activity are known, the actual body movements can be compared to movements that are "optimal" for that particular activity. This translates into a measure of efficiency and proficiency in the selected activity. For example, inexperienced runners have a larger vertical acceleration component than experienced runners. Optimal movement patterns can be looked up in a database with key (desired activity, body part), and a pattern-matching technique can be used to determine how the actual pattern compares to the optimal pattern. Moreover, suggestions to change movement patterns of the specific body part can be given, such as for example, "when striking a ball with a racket, try to move in a continuous circular motion, and do not stop the motion after impact, to maximize acceleration of the ball upon impact". Alternatively, movements associated with health problems such as a baseball-arm, can be detected and feedback can be provided about the undesired movements.

According to another aspect of the invention, the means for establishing that the subject is performing the predetermined activity is arranged for establishing that the subject is performing at least one of a predetermined number of predetermined activities. This allows the activity monitor to distinguish between a plurality of activities of the subject, so that feedback can be provided in relation to the established activity.

According to another aspect of the invention, it further comprises a further sensor arranged to be attached to the subject for obtaining a further measured value representing a further physical or physiological quantity of the subject, and wherein the means for deriving the subject-related value is arranged for deriving the measured value also in dependence on the further measured value. Advantageously, a plurality of sensors are attached at different positions on the subject and the means for deriving the subject-related value is arranged for combining the respective obtained measured values in order to increase the accuracy of the derived value. Advantageously, the sensors communicate with each other or with a central unit, for example by means of a wireless or wired connection, for coordinated processing of the obtained measured values.

The system for determining the calorie balance of a subject according to the invention is characterized in that it comprises the activity monitor set forth, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure. This system can provide accurate calorie balance because the activity parameter is determined with a high degree of accuracy.

The method according to the invention is characterized in that

- the method further comprises the step of determining the position of the sensor on the subject, and

- the step of deriving the subject-related value is performed also in dependence on the position of the sensor on the subject.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the method of the invention will be further elucidated and described with reference to the drawing, in which:

Figs. 1 A,B,C,D show sketches of a device with attachment means that can be attached at several positions on a subject.

Fig. 2 shows an activity monitor with user interface.

Fig. 3 shows an activity monitor comprising a device with a sensor connected to a separate unit by means of a wireless link.

Fig. 4 shows a diagram of an embodiment of the method according to the invention.

Figs. 5 A,B show diagrams of embodiments of the measuring method according to the invention including the compensation method according to the invention.

Fig. 6 shows a diagram of an embodiment of the method according to the invention including the method according to the invention to determine the position of the sensor on the subject.

Fig. 7 shows a diagram of an embodiment of the method according to the invention including the compensation initialization method according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1A shows an activity monitor 1 comprising a sensor 6 (shown in dotted lines), a display 10, and strap attachment means 5. The activity monitor 1 further comprises a microprocessor (not shown) for computing and displaying an activity parameter. The sensor 6 can comprise a single-axial or multi-axial accelerometer, a temperature sensor, an electrical sensor for measuring electrical body signals such as the ECG signal, a heart rate sensor, a pedometer, a global or local positioning system, or any other type of sensor. Such sensors are known to the skilled artisan. Figure 1B shows the activity monitor 1, fixed to a short strap 2 with a buckle 4, and Figure 1C shows the activity monitor 1 fixed to a long strap 3. The short strap 2 is suitable for attaching the activity monitor to a wrist or ankle, while the long strap 3 is suitable for attaching the activity monitor to a waist or chest. Figure 1D shows a side view of the activity monitor illustrating a clip 9 fixed to the back of the activity monitor, making it possible to attach the activity monitor to clothing. The activity monitor with accessories as shown can be attached at one of a plurality of positions on a subject. The display 10 can be a touch-screen display for having a subject provide input to the activity monitor.

Figure 2 shows an activity monitor 20 with at least one button 21,22, a display 23, and a sensor 24. The button can be used for receiving input from a user. Preferably, more buttons are provided to make it easier for the subject to provide different kinds of input to the activity monitor.

Figure 3 shows an activity monitor comprising a device 30 with a sensor 33. The device 30 does not have any buttons or display. The device 30 has means to communicate with a separate unit 31, preferably using a wireless link 32 such as WIFI or Bluetooth. The separate unit 31 is used to control the device 30. The separate unit 31, for example a personal computer or a personal digital assistant, comprises a microprocessor (not shown) for processing the information gathered by the device 30 by means of sensor 33. The separate unit 31 further comprises means for receiving user input and communicating the processed information to a user.

Figure 4 shows an embodiment of the method according to the invention for activity monitoring applicable to the case where the sensor 6 is attached at a reference position. In step 100, the sensor 6 delivers a measurement value at the reference position. Preferably, the sensor 6 is a tri-axial accelerometer, and the measurement value is a triple containing acceleration information in X, Y, and Z-direction. In step 101, the activity monitor computes the corresponding activity parameter, for example energy expenditure. For a tri-axial accelerometer attached to the back of the waist, a method to compute the corresponding energy expenditure is disclosed in "Daily physical activity, energy expenditure and physical fitness; assessment and implications" by Guy Plasqui, Ph.D. thesis, Maastricht University, 2004, referred to hereinafter as "Plasqui". The back of the waist is near the center of the body and a tri-axial accelerometer attached thereto provides a good estimation of overall movements.

Figure 5A shows an example of embodiment of the method according to the invention for activity monitoring applicable to the case where the sensor 6 is attached at a position on the subject that is not a reference position. In step 105, the sensor 6 delivers a measurement value measured at the position where the sensor is attached. After this, in step 106, the measurement value is compensated for the difference of the value at the position the sensor 6 is attached and the corresponding value at the reference position. After this, in step 108, the activity parameter, in this case energy expenditure, is computed using the method of computing the corresponding energy expenditure disclosed in Plasqui. The compensation method of step 106, in a very simple version, in this embodiment can be expressed as:

$$x_{\text{corrected}} = a + bx_{\text{raw}},$$

where x_{raw} represents the measured value at the position where the sensor 6 is attached, $x_{\text{corrected}}$ is the corrected measured value, and a and b are compensation constants that have been stored in a compensation database 107 as part of an initialization procedure. In a multivariate system, where the measurement value comprises a tuple, for example the X, Y, and Z-components measured by a tri-axial accelerometer, the compensation method can be expressed as:

$$x_{\text{corrected},i} = a_i + b_{i,1}x_{\text{raw},1} + b_{i,2}x_{\text{raw},2} + \cdots + b_{i,N}x_{\text{raw},N},$$

where $x_{\text{raw},1}, x_{\text{raw},2}, \ldots, x_{\text{raw},N}$ represent the N components of the measurement value tuple; $x_{\text{corrected},i}$ represents the i-th component of the corrected measurement value tuple $(x_{\text{corrected},1}, x_{\text{corrected},2}, \ldots, x_{\text{corrected},N})$, and a_i and $b_{i,j}$, for $i, j = 1, 2, \ldots, N$, are compensation

constants that have been stored in a compensation database 107 as part of an initialization procedure. This example of a compensation method is particularly easy to implement. Other, potentially more flexible compensation methods are easily conceivable. Such methods include higher order polynomials, generalized linear models, other statistical methods, artificial neural networks, and fuzzy logic methods.

Figure 5B shows an alternative embodiment of the method according to the invention for activity monitoring applicable to the case where the sensor 6 is attached at a position on the subject that is not a reference position. In step 110, the sensor 6 delivers a measurement value measured at the position where it is attached. After this, in step 111, the activity parameter, in this case energy expenditure, is computed using the method of computing the corresponding energy expenditure disclosed in Plasqui. Finally, in step 112 the computed energy expenditure is compensated for the difference of the energy expenditure as computed from the value measured at the position where the sensor 6 is attached and the "real" energy expenditure that would have been obtained if the sensor had been attached at the reference position. The compensation method, which is similar to the compensation method appearing in the embodiment according to Figure 5A, makes use of the information stored in the compensation database 113.

Figure 6 shows a diagram of an embodiment of a method of determining the position on the subject where the sensor 6 is attached and of computing the activity parameter, regardless of where the sensor was attached. In step 115, the measured value or a sequence of measured values is obtained from the sensor 6. Next, the position on the body is determined in step 116, using information from a feature database 117. To determine the position of the sensor 6 on the body, the signal from the sensor is analyzed for features that are position-dependent. Also, the subject is instructed to perform predefined standardized activities, such as walking, sitting, and standing, preferably for about 20 seconds each. Alternatively, the user can provide the activity monitor with input to indicate when he or she performs a standardized activity, and possibly, which standardized activity he or she performs. Combinations of the values during the standardized activities or the absolute measured values are used to determine the position of the sensor 6 on the subject. Thereto, a number of predefined rules are used. These rules can be in the form of "if…then" rules. An example of such a rule is: "if the measured value during walking is in the range of A to B times higher than during sitting, the sensor 6 is positioned on the lower arm", where A and B are constants stored in the feature database 117. Another example of such a rule is: "if the measured value during walking is in the range of C to D, the sensor 6 is positioned on the

leg", where *C* and *D* are constants stored in the feature database 117. The rules can also be implemented in terms of fuzzy logic rules. Other ways to provide a set of rules, including for example neural network methods and logic programming, are obvious to the skilled artisan. In a preferred embodiment, the position of the sensor 6 on the subject is determined by means of pattern recognition. The pattern recognition can be performed for example by correlating a signal obtained from the sensor with a signal stored in the feature database 117. The pattern recognition can be performed in the time domain, the frequency domain, or another domain, preferably a time-frequency domain such as a wavelet domain. Pattern recognition can be performed in many ways known to the skilled artisan. For example, techniques used in speech recognition can be applied.

After the position of the sensor 6 on the subject has been determined in step 116, and the position is not a reference position (step 118, branch 122), in step 119 the measured value is compensated for by the difference between the value at the position at which the sensor is attached and the corresponding value at a reference position, making use of the information in a compensation database 120, in a way similar to the embodiment according to Figure 5A. Finally, in step 121 the activity parameter is computed from the, possibly compensated, measured value, in a way similar to the embodiment according to Figure 5.

In another embodiment, the measured value is first converted to an activity parameter, and the activity parameter is used to determine the position of the sensor 6 on the subject in a way similar to what is described above. In that case, after the position has been determined, the computed activity parameter is compensated for the difference between the computed activity parameter and the corresponding activity parameter computed from a value measured at a reference position, while information stored in a compensation database is made use of in a way similar to the embodiment according to Figure 5B. It is also possible to use other quantities relating to measured values obtained from the sensor 6, in the step to determine the position 116 and/or in the step to compensate for the difference 119.

Figure 7 shows a diagram of an embodiment of an initialization procedure for the compensation database. In this embodiment, a sequence of steps is performed iteratively. As a first step 130, *i* and *j* are both initialized to 1. Each iteration starts with step 131 comprising an instruction to the subject to perform predefined activity *i*. The instruction can comprise a spoken instruction to walk, sit, or stand, or it can for example comprise showing the activity on a display for a predefined duration. Then, in step 132 the subject performs the predefined activity *i*, while the sensor 6 attached at position *j* on the subject measures a

physical value, in this case tri-axial acceleration, in step 133. Next, in step 134 the essential features are extracted from the measured value signal and stored in a feature database 135. These essential features may comprise decision rules or constants that are part of decision rules, similar to the constants A, B, C, and D appearing in the description of the embodiment according to Figure 6. Similarly, essential signal patterns can be stored in the time domain, frequency domain, time-frequency domain, or any other domain or combination of domains. Simultaneously, if position j is not a reference position (step 136, branch 145), in step 137 compensation parameters describing the difference between the measured value at the position of the sensor 6 on the subject and the corresponding value at a reference position are determined and stored in a compensation database 138. These compensation parameters may comprise constants appearing in the compensation method, similar to the constants a, b, a_i, and $b_{i,j}$ occurring in the description of the embodiment according to Figure 5A.

To conclude an iteration, i is increased in step 139, and if i is smaller than or equal to the number of predefined activities (step 140, branch 147), the iteration steps are repeated; otherwise, j is increased in step 141, and if j is smaller than or equal to the predefined number of positions (step 142, branch 148), i is set to 1 in step 143 and the iteration steps are repeated. If j is greater than the predefined number of positions (step 142, branch 149), the initialization procedure is finished.

In general, this sequence could be paralleled further, for example by using a plurality of sensors 6 to measure the value at a plurality of positions on the subject simultaneously. In this embodiment, the steps of extracting compensation parameters and extracting essential signal features are performed in parallel. However, they can also be performed sequentially. In an alternative embodiment, the activity parameter is computed after the sensor 6 has delivered the signal in step 133, and before extracting essential features in step 134 and determining compensation parameters in step 137. It is also possible to compute at least one derived quantity from the values measured by the sensor 6, and perform the steps of extracting essential features and determining compensation parameters based on the derived quantity.

In another embodiment, the initialization of the compensation database and the feature database are performed on the basis of a population of subjects. All subjects are asked to perform the standardized activities, the measured values are obtained from the sensor 6 at multiple positions on the subject, and after the data of all subjects have been collected and stored in an intermediate database, the compensation database and the feature database are

filled with values that are representative of the population. This embodiment has the advantage that the activity monitor needs to be initialized only once, possibly by the manufacturer, and after that an unlimited number of activity monitors can be produced using the same database values.

It will be appreciated that the invention also extends to computer programs, particularly computer programs on or in a carrier, adapted for putting the invention into practice. The program may be in the form of source code, object code, a code intermediate source and object code such as partially compiled form, or in any other form suitable for use in the implementation of the method according to the invention. The carrier may be any entity or device capable of carrying the program. For example, the carrier may include a storage medium, such as a ROM, for example a CD ROM or a semiconductor ROM, or a magnetic recording medium, for example a floppy disc or hard disk. Further, the carrier may be a transmissible carrier such as an electrical or optical signal, which may be conveyed via electrical or optical cable or by radio or other means. When the program is embodied in such a signal, the carrier may be constituted by such cable or other device or means. Alternatively, the carrier may be an integrated circuit in which the program is embedded, the integrated circuit being adapted for performing, or for use in the performance of, the relevant method.

A measuring system comprises a sensor arranged to be attached to a subject for obtaining a measured value representing a physical or a physiological quantity of the subject. The measuring system further comprises means for deriving a subject-related value from the measured value. The sensor is arranged to be attached at one of a plurality of positions on the subject. The measuring system further comprises means for establishing the position of the sensor on the subject. The means for deriving the subject-related value is arranged for deriving the subject-related value also in dependence on the position of the sensor on the subject.

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. Use of the verb "to comprise" and its conjugations does not exclude the presence of elements or steps other than those stated in a claim. The article "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. The invention may be implemented by means of hardware comprising several distinct elements, and by means of a suitably programmed computer. In the device claim enumerating several means, several of these

means may be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

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Date: 2008-07-15

Re: **Observations on the PCT search report and written opinion**

With reference to the Written Opinion of the International Searching Authority dated, July 2nd, 2007, the applicant herewith files the following observations. These observations as well as the amended claims and description replace the corresponding documents now on file. When referring to the application as filed, reference is made to the published patent application WO2007/069127.

Amended claims

Applicant submits amended claims 1-15 to replace claims 1-21 presently on file.
Amended claims (clean version and with track changes) have been attached to this letter.

In new claim 1 the phrase 'from said plurality of positions on a subject' is added in order to improve clarity of the claim. Basis for the amendment can be derived from the passage at page 3 lines 27-34. Furthermore it is noted that the present amendment is in line with all embodiments as described in the 'Detailed description of the invention' section (see for example page 11 lines 6-32).

New claim 3 is based on the subject matter of claims 3 and 4 presently on file.

The other claims have been renumbered.

Novelty and inventive step independent claims

In line with the International Search Report and the Written opinion reference is made to the following documents;

D1: US5111826
D2: EP1254629

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None of the documents of D1 and D2 discloses a measuring system comprising a sensor arranged to be attached at one of a plurality of positions on a subject for obtaining a measured value. On the contrary D1 and D2 teach to wear a (blood pressure) sensor on a fixed position. In D1 a sensor is worn on one's fingertip, while in D2 the sensor is worn on one's wrist.

D1 and D2 furthermore do not disclose means for establishing the position of the sensor on the subject from said plurality of positions on a subject, and means for deriving a subject-related value from the measured value also in dependence on said position of the sensor on the subject.

D1 discloses a blood pressure sensor that is worn on one's fingertip and that has a hand position sensor. The hand position sensor measures the difference in height between the hand and the heart to correct the readings from the blood pressure sensor for hand-to-heart height differences, which differences directly correspond to the differences between finger and heart blood pressure.

D2 discloses an electronic sphygmomanometer for measuring blood pressure that is worn on one's wrist and has gravitational acceleration sensors. The sensors determine altitude differences between the heart and the pressure reference position of the sphygmomanometer (on the wrist) for correcting a blood pressure value.

Summarizing one could state that the measuring systems from both D1 and D2 do determine a position of a sensor worn on a subject. However this determination relates to the position of the sensor on a fixed position on a subject relative to the heart of a subject. Obviously this is different than establishing the position of the sensor on the subject from a plurality of positions on said subject.

There is no teaching in D1 or D2 that would lead a man skilled in the art to a sensor that can be worn at various positions on a subject, while said position can be determined and the sensor can be corrected based on said position.

The advantage of the measuring system according to claim 1 is that it provides a measuring system that yields a more accurate estimate of a parameter relating to a subject. This is stated at page 3 lines 18, 19 of the application as filed.

In view of the aforementioned considerations it is respectfully submitted that new claims 1 and 15 are novel and involve an inventive step over the cited prior art.

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Date: 2008-07-15

Formal requirements

The description has been brought into conformity with the present claim amendments, while the relevant disclosures of D1 and D2 are briefly indicated. The amended description has been enclosed with this letter.

The applicant reserves his right to further amend the claims, while using any patentable subject matter in the application as filed.

Yours faithfully,
PHILIPS INTERNATIONAL B.V.
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Europäisches Patentamt
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Letter accompanying subsequently filed items

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Tel. +49(0)30 25901-0 | Fax -840

The document(s) listed below is (are) subsequently filed documents pertaining to the following application:

Application number	06832085.2
Applicant's or representative's reference	PH003603EP2

	Description of document	Original file name	Assigned file name
1	Amendments before examination	PH003603 EP2 brf EPO_15.pdf	ABEX-1.pdf
2	Amended description	PH003603 EP2 Amended description - track changes _15.pdf	DESCPAMD-1.pdf
3	Amended description	PH003603 EP2 Amended description - clean _15.pdf	DESCPAMD-2.pdf
4	Amended claims	PH003603 EP2 Amended Claims - clean _15.pdf	CLMSPAMD-1.pdf
5	Amended claims	PH003603 EP2 Amended Claims - track changes _15.pdf	CLMSPAMD-2.pdf

	Payment	
1	Mode of payment	Not specified

Annotations

Statement
The undersigned hereby declares that the subsequently filed items do NOT contain or are NOT intended to contain any communication relating either an appeal, an opposition, a limitation, a revocation proceeding or any proceedings for review (Special edition No. 3 OJ EPO 2007, A.4. Article 2(3) "Paragraph 1 shall not apply to documents in opposition proceedings, in European patent limitation or revocation proceedings, in appeal proceedings, or in proceedings for review by the Enlarged Board of Appeal of decisions of the boards of appeal.").

Signatures

Place:	**Eindhoven**
Date:	**15.July 2008**
Signed by:	**NL, Philips IP&S, M. van Velzen 7752**
Capacity:	**(Koninklijke Philips Electronics N.V.)**

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44*bis*)

Applicant's or agent's file reference PH003603WO1	**FOR FURTHER ACTION**	See item 4 below
International application No. PCT/IB2006/054599	International filing date *(day/month/year)* 05 December 2006 (05.12.2006)	Priority date *(day/month/year)* 15 December 2005 (15.12.2005)
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237		
Applicant KONINKLIJKE PHILIPS ELECTRONICS N.V.		

1. This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 *bis*.1(a).

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

   In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.

3. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

4. The International Bureau will communicate this report to designated Offices in accordance with Rules 44*bis*.3(c) and 93*bis*.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44*bis* .2).

	Date of issuance of this report 18 June 2008 (18.06.2008)
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 82 70	Authorized officer Cecile Chatel e-mail: pt13.pct@wipo.int

Form PCT/IB/373 (January 2004)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

see form PCT/ISA/220

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)* see form PCT/ISA/210 (second sheet)	
Applicant's or agent's file reference see form PCT/ISA/220	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/IB2006/054599	05.12.2006	15.12.2005

International Patent Classification (IPC) or both national classification and IPC
INV. A61B5/00

Applicant
KONINKLIJKE PHILIPS ELECTRONICS N.V.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notifed the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA:	Date of completion of this opinion	Authorized Officer
European Patent Office - Gitschiner Str. 103 D-10958 Berlin Tel. +49 30 25901 - 0 Fax: +49 30 25901 - 840	see form PCT/ISA/210	Clevorn, Jens Telephone No. +49 30 25901-556

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/IB2006/054599

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

      ☐ a sequence listing

      ☐ table(s) related to the sequence listing

   b. format of material:

      ☐ on paper

      ☐ in electronic form

   c. time of filing/furnishing:

      ☐ contained in the international application as filed.

      ☐ filed together with the international application in electronic form.

      ☐ furnished subsequently to this Authority for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/IB2006/054599

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	
	No:	Claims	1-21
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-21
Industrial applicability (IA)	Yes:	Claims	1-21
	No:	Claims	

2. Citations and explanations

see separate sheet

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY (SEPARATE SHEET)

International application No.
PCT/IB2006/054599

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following documents:

   D1: US5111826
   D2: EP1254629
   D3: US2003/65257

2. The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 1 and 21 is not new in the sense of Article 33(2) PCT.

2.1. The document D1 discloses (the references in parentheses applying to this document)

   A measuring system comprising
   - a sensor (14) arranged to be attached at one of a plurality of positions on a subject for obtaining a measured value representing a physical or a physiological quantity of the subject (blood pressure), and
   - means for establishing the position of the sensor on the subject (col. 7, par. 2; e.g. by triangulation, even though the device is called hand position sensor, it actually determines the sensor position with respect to the subject's chest), and
   - means for deriving a subject-related value from the measured value also in dependence on the position of the sensor on the subject (using the sensor height relative to the heart to correct the blood pressure; col. 4, ll. 42-50).

   Claim 1 is therefore not novel.

2.2. Claim 21 is not novel mutatis mutandis.

2.3. D2 ([0052]-[0056], [0070]) likewise discloses the subject-matter of claims 1 and 21.

3. As to the dependent claims

Dependent claim 2-20 do not appear to contain any additional features which meet the requirements of the PCT with respect to novelty and/or inventive step.

The features of these claims are merely straightforward possibilities, which the skilled person would select, in accordance with circumstances, without the exercise of inventive skill, in order to solve the problem posed. They come within the scope of the customary practice followed by persons skilled in the art, especially as the advantages thus achieved can be readily contemplated in advance.

4. Independent claims should have been in the two-part form in accordance with Rule 6.3(b) PCT.

5. If amendments are filed, the description, in particular the statement of invention, should be brought into conformity with the amended claims. To meet the requirements of Rule 5.1(a)(ii) PCT, the documents D1 and D2 should be identified in the description and the relevant background art disclosed therein should be briefly discussed.

6. If amendments are filed, the applicant is requested to effect the amendments by filing replacement pages for only those pages which have been amended. Unnecessary recasting of the description should be avoided. In order to facilitate an examination of the conformity of the amended application with the requirements of Article 19(2) PCT, the applicant is requested to *clearly identify the amendments carried out, irrespective of whether they concern amendments by addition, replacement or deletion, and to indicate the passages of the application as filed on which these amendments are based.* Without such indications, the amendments might not be taken into account by the IPEA when drawing up an International Preliminary Examination Report.

Europäisches Patentamt
European Patent Office
Office européen des brevets

Acknowledgement of receipt

We hereby acknowledge receipt of the form for entry into the European phase (EPO as designated or elected Office) as follows:

Submission number	382451	
PCT application number	PCT/IB2006/054599	
EP application number	06832085.2	
Date of receipt	13 May 2008	
Receiving Office	European Patent Office, The Hague	
Your reference	PH003603EP2	
Applicant		
Country		
Documents submitted	package-data.xml application-body.xml AMDESC.pdf\PH003603-description-clean.pdf (5 p.) OTHER-1.pdf\PH003603WO-letter.pdf (3 p.)	ep-euro-pct.xml epf1200.pdf (3 p.) AMCLMS.pdf\PH003603- claims-clean 18.04.pdf (3 p.)
Submitted by	CN=A. Groenendaal 908,O=Philips IP&S,C=NL	
Method of submission	Online	
Date and time receipt generated	13 May 2008, 13:28:48 (CEST)	
Digest	39:DF:C9:24:D9:51:B7:44:9C:62:66:1A:53:9A:09:4B:8B:CF:1C:AF	

/European Patent Office/

CLAIMS:

1. A measuring system (1) comprising

- a sensor (6) arranged to be attached at one of a plurality of positions on a subject for obtaining a measured value representing a physical or a physiological quantity of the subject, and

- means for establishing the position of the sensor on the subject, and

- means for deriving a subject-related value from the measured value also in dependence on the position of the sensor on the subject.

2. The measuring system (1) according to claim 1, wherein the plurality of positions includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head.

3. The measuring system (1) according to claim 1, wherein the derived value comprises an activity parameter of the subject, the activity parameter comprising energy expenditure.

4. The measuring system (1) according to claim 1, wherein the activity parameter represents a degree of activity of the body part the sensor is attached to.

5. The measuring system (1) according to claim 1, wherein the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration.

6. The measuring system (1) according to claim 1, further comprising means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on the position of the sensor on the subject, and the sensor is arranged for generating a further measured value for each quantity in the selected subset.

7. The measuring system (1) according to claim 1, further comprising

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and
- means for deriving the subject-related value from the estimated measured value.

8. The measuring system (1) according to claim 1, wherein the means for determining the position of the sensor on the subject is arranged for performing the determining in dependence on the measured value.

9. The measuring system (1) according to claim 8, further comprising means for obtaining from the sensor (6) a plurality of measured values measured during a time interval, and wherein the means for determining the position of the sensor on the subject is arranged for performing the determining in dependence on the measured values measured during the time interval.

10. The measuring system (1) according to claim 8 or 9, wherein the means for determining the position of the sensor (6) on the subject is arranged for performing the determining on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively.

11. The measuring system (1) according to claim 9, wherein the means for determining the position of the sensor (6) on the subject comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval.

12. The measuring system (1) according to claim 8 or 9, further comprising means for determining that the user is performing a standardized activity, and wherein the means for determining the position of the sensor on the subject is arranged for using at least one measured value obtained from the sensor (6), the measured value relating to a time the user is performing the standardized activity.

13. The measuring system (1) according to claim 1, further comprising a user interface for receiving input from a user related to the position of the sensor on the subject.

14. A system for determining the calorie balance of a subject, the system comprising the measuring system (1) according to claim 3, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure.

15. A method of estimating a derived value relating to a subject, the method comprising

- obtaining at least one measured value from a sensor (6) attached to the subject, the measured value representing a physical or a physiological quantity of the subject, and
- establishing the position of the sensor on the subject, and
- deriving the subject-related value from the measured value also in dependence on the position of the sensor on the subject.

Detection and compensation method for monitoring the place of activity on the body

FIELD OF THE INVENTION

The invention relates to a measuring system comprising

- a sensor arranged to be attached to a subject for obtaining a measured value representing a physical or a physiological quantity of the subject, and

- means for deriving a subject-related value from the measured value.

The invention also relates to a system for determining the calorie balance of a subject.

BACKGROUND OF THE INVENTION

Overweight and obesity are growing problems; for example over 60% of the American population can be classified as overweight or obese. Weight gain occurs when a human has a higher energy intake (food) than energy expenditure (resting metabolic rate + activity). Since this unbalance causes the weight gain problem, many weight loss programs require that users log the food consumed and activities done in order to estimate the calorie balance.

Tables and equations exist for converting nutrition values and activities into calorie intake and expenditure, respectively. However, manual calorie counting is a cumbersome process requiring knowledge, time, effort, recording and discipline. Thus, calorie logging is a problem for many people and hence it is a challenge for researchers to find a solution therefore.

In US patent application publication US2003/0065257, a combination of a diet and activity-monitoring device is described for monitoring both the consumption and activity of the subject. Such a monitoring device includes a body activity monitor for monitoring the body activity of the subject. The body activity monitor is operable to output a signal indicative of the subject's body activity. An activity calculator may also be provided, which receives the activity indicative signal and determines body activity level and/or energy expenditure for the subject. The monitoring device may take the form of a wristwatch-style device or a belt or clothing-mounted monitor. The monitoring device may comprise a heart rate monitor. The heart rate of the subject increases with activity and decreases when the

When the user uses the system for the first time, he or she may designate certain movement patterns as correlating with certain activities. This will aid to calibrate the activity monitor.

Each of the described activity monitors and sensors is designed to be placed on a single position on the body. Bodily signals such as acceleration and ECG signals, are measured local to the position where the sensor is attached to the object. For example, acceleration measured by an accelerometer on the wrist includes motion of the arm, which is not detected by an accelerometer mounted on the waist.

The existing activity monitors, including for example a wrist strap or a waist belt, are often designed to be worn on one place on the body. The existing activity monitor is calibrated such that it provides accurate results if it is attached at a predefined location on the body. If the activity monitor is attached at a different location, the measured activity may be less accurate. If the activity monitor is not attached at the reference position, errors exceeding 5% in the estimation of energy expenditure may occur. This amounts to an error exceeding approximately 100 kilocalories per day.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a measuring system that yields a more accurate estimate of a parameter relating to a subject.

According to the invention, this object is achieved in that

- the sensor is arranged to be attached at one of a plurality of positions on the subject,

- the measuring system further comprises means for establishing the position of the sensor on the subject from said plurality of positions on a subject, and

- the means for deriving the subject-related value is arranged for deriving the subject-related value also in dependence on said position of the sensor on the subject.

With these provisions, the accuracy of the derived value is guaranteed for any of a plurality of positions on the body. The subject may attach the sensor at any preferred position on the body, and can preferably attach it at a different position whenever he or she desires to do so.

Subjects may have different preferences where they prefer wearing the sensor, and the same subject may prefer wearing the sensor at different locations, depending on for example the location of the subject, the local weather, or the activity the subject is performing at any given time. Advantageously, a plurality of sensors are attached at different

positions on the subject and the means for deriving the subject-related value is arranged for combining the respective obtained measured values in order to increase the accuracy of the derived value.

It is noted that US 5 111 826 discloses a blood pressure sensor that is warm on one's fingertip and that has a hand position sensor. The hand position sensor measures the difference in height between the hand and the heart to correct the readings from the blood pressure sensor for hand-to-heart height differences, which differences directly correspond to the differences between finger and heart blood pressure. Document EP 1 254 629 discloses an electronic sphygmomanometer for measuring blood pressure that is worn on one's wrist and has gravitational acceleration sensors to determine altitude differences between the heart and the pressure reference position of the sphygmomanometer for correcting a blood pressure value.

The invention is particularly suitable for determining a derived value relating to a human or an animal.

According to an aspect of the invention, the plurality of positions includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head. This allows for an especially flexible use of the activity monitor, because the positions mentioned are especially well suited for measuring the activity of the subject, and they are particularly convenient for wearing a sensor device.

According to another aspect of the invention, the derived value comprises an activity parameter of the subject. With this aspect, the measuring system becomes an activity monitor that enables to monitor the degree of activity performed by the subject. Other possible derived values include a temperature value or an ECG value that is automatically compensated for by the location of the sensor. Advantageously, the position of the sensor on the subject is established in dependence on an accelerometer measurement and a temperature or ECG value is compensated for in dependence on the established position.

According to an aspect of the invention, the activity parameter comprises energy expenditure. This makes the activity monitor particularly suitable for use in weight management.

According to another aspect of the invention, the activity parameter represents the degree of activity of the body part the sensor is attached to. When the position of the sensor on the subject is known, it becomes possible to monitor activity parameters related to a specific body part. For example, if the sensor is attached to the arm, the activity monitor can track energy expenditure, and in addition can track local acceleration of the arm. For

example, with additional information provided by fitness equipment, the forces applied to the arm can be estimated and combined with acceleration information provided by the sensor to obtain local energy expenditure. This enables subjects to optimize a training schedule to train a specific body part. Also, if a predefined safety limit is exceeded, this can be provided as feedback to the user to avoid potentially dangerous situations.

According to an aspect of the invention, the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration. These examples of measured values are correlated with activity.

The system for determining the calorie balance of a subject according to the invention is characterized in that it comprises the activity monitor set forth, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure. This system can provide accurate calorie balance because the activity parameter is determined with a high degree of accuracy.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the method of the invention will be further elucidated and described with reference to the drawing, in which:

Figs. 1 A,B,C,D show sketches of a device with attachment means that can be attached at several positions on a subject.

Fig. 2 shows an activity monitor with user interface.

Fig. 3 shows an activity monitor comprising a device with a sensor connected to a separate unit by means of a wireless link.

Fig. 4 shows a diagram of an embodiment of the method according to the invention.

Figs. 5 A,B show diagrams of embodiments of the measuring method according to the invention including the compensation method according to the invention.

Fig. 6 shows a diagram of an embodiment of the method according to the invention including the method according to the invention to determine the position of the sensor on the subject.

Fig. 7 shows a diagram of an embodiment of the method according to the invention including the compensation initialization method according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1A shows an activity monitor 1 comprising a sensor 6 (shown in dotted lines), a display 10, and strap attachment means 5. The activity monitor 1 further comprises a microprocessor (not shown) for computing and displaying an activity parameter. The sensor 6 can comprise a single-axial or multi-axial accelerometer, a temperature sensor, an electrical

PHILIPS

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Ref: PH003603
KRUK/SH
Date: 2008-02-21

Re: **Observations on the PCT search report and written opinion**

With reference to the Written Opinion of the International Searching Authority dated, July 2nd, 2007, the applicant herewith files the following observations. When referring to the application as filed, reference is made to the published patent application WO2007/069127.

Amended claims

Applicant submits amended claims 1-15 to replace claims 1-21 presently on file. Amended claims (clean version and with track changes) have been attached to this letter.

In claim 1 the phrase 'from said plurality of positions on a subject' is added in order to improve clarity of the claim. Basis for the amendment can be derived from the passage at page 3 lines 27-34. Furthermore it is noted that the present amendment is in line with all embodiments as described in the 'Detailed description of the invention' section (see for example page 11 lines 6-32.

Claim 21 has been deleted. The other claims have not been amended.

Novelty and inventive step independent claims

In line with the International Search Report and the Written opinion reference is made to the following documents;

D1: US5111826
D2: EP1254629

Philips International B.V.
Philips Intellectual Property & Standards
Office address: High Tech Campus 44, Bldg. HTC44
5656 AE Eindhoven, The Netherlands
Tel +31 40 279 11 11
Fax +31 40 274 34 89
Commercial Register Eindhoven no. 17047664
www.ip.philips.com

PHILIPS

None of the documents of D1 and D2 discloses a measuring system comprising a sensor arranged to be attached at one of a plurality of positions on a subject for obtaining a measured value. On the contrary D1 and D2 teach to wear a (blood pressure) sensor on a fixed position. In D1 a sensor is worn on one's fingertip, while in D2 the sensor is worn on one's wrist.

D1 and D2 furthermore do not disclose means for establishing the position of the sensor on the subject from said plurality of positions on a subject, and means for deriving a subject-related value from the measured value also in dependence on said position of the sensor on the subject.

D1 discloses a blood pressure sensor that is warm on one's fingertip and that has a hand position sensor. The hand position sensor measures the difference in height between the hand and the heart to correct the readings from the blood pressure sensor for hand-to-heart height differences, which differences directly correspond to the differences between finger and heart blood pressure.

D2 discloses an electronic sphygmomanometer for measuring blood pressure that is worn on one's wrist and has gravitational acceleration sensors. The sensors determine altitude differences between the heart and the pressure reference position of the sphygmomanometer (on the wrist) for correcting a blood pressure value.

Summarizing one could state that the measuring systems from both D1 and D2 do determine a position of a sensor worn on a subject. However this determination relates to the position of the sensor on a fixed position on a subject relative to the heart of a subject. Obviously this is different than establishing the position of the sensor on the subject from a plurality of positions on said subject.

There is no teaching in D1 or D2 that would lead a man skilled in the art to a sensor that can be worn at various positions on a subject, while said position can be determined and the sensor can be corrected based on said position.

The advantage of the measuring system according to claim 1 is that it provides a measuring system that yields a more accurate estimate of a parameter relating to a subject. This is stated at page 3 lines 18, 19 of the application as filed.

In view of the aforementioned considerations it is respectfully submitted that claim 1 is novel and involves an inventive step over the cited prior art.

Formal requirements

The description has been brought into conformity with the present claim amendments, while the relevant disclosures of D1 and D2 are briefly indicated. The amended description has been enclosed with this letter.

PHILIPS

Ref: PH003603
KRUK/SH
Date: 2008-02-21

Independent claim 1 now has a two-part form, the preamble stating all features known from US2003/0065257.

The applicant reserves his right to further amend the claims, while using any patentable subject matter in the application as filed.

Yours faithfully,
PHILIPS INTERNATIONAL B.V.
Intellectual Property & Standards

Encl.

Europäisches Patentamt
European Patent Office
Office européen des brevets

Entry into the European phase (EPO as designated or elected Office)

To the European Patent Office

European application number	
PCT application number	PCT/IB2006/054599
PCT publication number	
Applicant's or representative's reference	PH003603EP2

1. Applicant

Indications concerning the applicant(s) are contained in the international publication or were recorded by the International Bureau after the international publication. ☒

Changes which have not yet been recorded by the International Bureau are set out here: ☐

2. Representative

This is the representative who will be listed in the Register of European Patents and to whom notifications will be made

Representative 1

Name	SCHOUTEN Marcus, M.
Registration No	100030220
Company:	
Address of place of business:	P.O. Box 220 5600 AE Eindhoven, Netherlands
Telephone	+31 40 2740590
Fax	+31 40 2743489
e-mail	

3. Authorisation

An individual authorisation is attached. ☐

A general authorisation has been registered under No: ☐

A general authorisation has been filed, but not yet registered. ☐

The authorisation filed with the EPO as PCT receiving Office expressly includes the European phase. ☐

4. Request for examination

Examination of the application under Art. 94 EPC is hereby requested. The examination fee is being (has been, will be) paid. ☒

Request for examination in an admissible non-EPO language: ☒

Verzocht wordt om onderzoek van de aanvrage als bedoeld in Art. 94.

The applicant waives his right to be asked under Rule 70(2) EPC whether he wishes to proceed further with the application. ☐

5. Copies

Additional copies of the documents cited in the supplementary European search report are requested. ☐

Number of additional sets of copies

6. Documents intended for proceedings before the EPO

6.1 Proceedings before the EPO as designated Office (PCT I) are to be based on the following documents:

the application documents published by the International Bureau (with all claims, description and drawings), where applicable with amended claims under Art. 19 PCT ☐

unless replaced by the amendments attached. ☒

Where necessary, clarifications should be attached as `Other documents`

6.2 Proceedings before the EPO as elected Office (PCT II) are to be based on the following documents:

the documents on which the international preliminary examination report is based, including any annexes ☐

unless replaced by the amendments attached. ☐

Where necessary, clarifications should be attached as `Other documents`

If the EPO as International Preliminary Examining Authority has been supplied with test reports, these may be used as the basis of proceedings before the EPO. ☐

7. Translations

Translations in one of the official languages of the EPO (English, French, German) are attached as crossed below: ☐

** In proceedings before the EPO as designated or elected Office (PCT I + II):*

Translation of the international application (description, claims, any text in the drawings) as originally filed, of the abstract as published and of any indication under Rule 13bis.3 and 13bis.4 PCT regarding biological material ☐

Translation of the priority application(s) (to be filed only at the EPO's request, Rule 53(3) EPC) ☐

It is hereby declared that the international application as originally filed is a complete translation of the previous application (Rule 53(3) EPC) ☐

** In addition, in proceedings before the EPO as designated Office (PCT I):*

Translation of amended claims and any statement under Art. 19 PCT, if the claims as amended are to form the basis for the proceedings before the EPO (see Section 6). ☐

** In addition, in proceedings before the EPO as elected Office (PCT II):*

Translation of annexes to the international preliminary examination report ☐

8. Biological material

The invention uses and/or relates to biological material deposited under Rule 31 EPC. ☐

The particulars referred to in Rule 31(1)(c) EPC (if not yet known, the depositary institution and the identification reference(s)) [number, symbols, etc.] of the depositor) are given in the international publication or in the translation submitted in Section 7 on: ☐

page(s) / line(s)

The receipt(s) of deposit issued by the depositary institution

is (are) enclosed. ☐

will be filed later. ☐

Waiver of the right to an undertaking from the requester pursuant to Rule 33(2) EPC attached. ☐

9. Nucleotide and amino acid sequences

The items pursuant to Rules 5.2 and 13ter PCT, Rules 30 and 163(3) EPC are already with the EPO. ☐

The sequence listing is attached in PDF format. ☐

The sequence listing does not include matter which goes beyond the content of the application as filed. ☐

The sequence listing data is also attached in computer-readable form in accordance with WIPO Standard 25. ☐

The sequence listing data in computer-readable form in accordance with WIPO Standard 25 is identical to the sequence listing in PDF format. ☐

10. Designation fees

All the contracting states party to the EPC at the time of filing of the international patent application and designated in the international application are deemed to be designated (see Article 79(1) EPC). ☒

AT BE BG CH&LI CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LT LU LV MC NL PL PT RO SE SI SK TR

10.1 It is currently intended to pay fewer than seven designation fees, for the following contracting states: ☐

10.2 If contracting states are indicated in Section 10.1, it is agreed that for the contracting states not thus indicated no communication under Rule 112(1) EPC ☐

be issued and further processing be excluded.

11. Extension of the European patent

This application is deemed to be a request to extend the European patent application and the European patent granted in respect of it to all the non-contracting states to the EPC designated in the international application and with which extension agreements are in force on the date on which the international application is filed. However, the extension only takes effect if the prescribed extension fee is paid.

☐

It is currently intended to pay the extension fee for the following states:

Note: Under the automatic debiting procedure, extension fees will only be debited for states indicated here, unless the EPO is instructed otherwise before expiry of the period for payment.

12. List of enclosed documents

	Description of document	Original file name	Assigned file name
1	AMDESC	PH003603-description-clean.pdf	AMDESC.pdf
2	AMCLMS	PH003603- claims- clean 18.04.pdf	AMCLMS.pdf
1	Observations on the PCT search report and written opinion	PH003603WO-letter.pdf	OTHER-1.pdf

13. Mode of payment: Automatic debit order

☒

Currency: EUR

The European Patent Office is hereby authorised, under the Arrangements for the automatic debiting procedure, to debit from the deposit account indicated any fees and costs falling due.

Deposit account number: 28090021

Account holder: Philips International B.V.-IP&S

14. Any refunds should be made to the following EPO deposit account:

☒

Number and account holder: Philips International B.V.-IP&S, 28090021

15. Fees

16. Annotations

17. Signature(s) of applicant(s) or representative

Place: **Eindhoven**

Date: **13.May 2008**

Signed by: **NL, Philips IP&S, A. Groenendaal 908**

Capacity: **(Representative)**

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PAYS-BAS

For any questions about this communication:
Tel.:+31 (0)70 340 45 00

Date
25.04.08

Reference	Application No./Patent No.
	06832085.2 - 1526 PCT/IB2006054599

Applicant/Proprietor
Koninklijke Philips Electronics N.V.

Entry into the European phase before the European Patent Office

The following information describes the procedural steps required for entry into the European phase before the European Patent Office (EPO). You are advised to read it carefully because failure to take the necessary action in due time can lead to a loss of rights.

1. The above mentioned international patent application has been given the **European application No. 06832085.2**.

2. Applicants **without a residence or their principal place of business** in an EPC Contracting State may themselves initiate European processing of their international applications, provided they do so before expiry of the 31st month from the priority date.

   During the European phase before the EPO as designated or elected Office, however, such applicants **must** be represented by a professional representative (Art. 133(2) and Art. 134(1) and (8) EPC).

   Where, at the expiry of the time period laid down in Rule 163(5) EPC, the requirements of Article 133(2) EPC have not been complied with, the European patent application will be **refused**, pursuant to Rule 163(6) EPC.

   Please note that a professional representative authorised to act before the EPO and who acted for the applicant during the international phase does not automatically become the representative for the European phase. Applicants are therefore strongly advised to appoint in good time any representative they wish to initiate the European phase for them; otherwise the EPO has to send all communications directly to the applicant.

3. Applicants **with a residence or their principal place of business** in an EPC Contracting State are not obliged to appoint for the European phase a professional representative authorised to act before the EPO. However, in view of the complexity of the procedure it is recommended that they do so.

4. Applicants and professional representatives are also strongly advised to initiate the European phase using **EPO Form 1200**. It is available free of charge from the EPO or via the EPO website at **http://www.epo.org**. Similarly, it can be or generated with the epoline® Online Filing Software, obtainable free of charge from the EPO (**http://www.epoline.org**) The use of the form is not compulsory.

5. Where the EPO is acting as designated or elected Office (Art. 22(1) and (3) and Art. 39(1) PCT), to enter the European phase before the EPO, the **following acts** must be performed by the applicant **within 31 months** from the date of filing of the international application or (where applicable) the earliest priority date:

   a) Supply a translation of the international application into an EPO official language, if the International Bureau did not publish the application in such language (Art. 22(1) PCT and R. 159(1)(a) EPC);

   b) Specify the application documents, as originally filed or as amended, on which the European grant procedure is to be based (R. 159(1)(c) EPC);

   c) Pay the filing fee and, where a supplementary European search report has to be drawn up, the search fee (R. 159(1)(c) and (e) EPC);

   d) Pay the designation fee for each designated Contracting State if the time limit laid down in Rule 39(1) EPC (i.e. six months after publication of the international search report) has expired before the 31-month period pursuant to Rule 159(1) EPC (R. 159(1)(d) EPC);

   e) File the request for examination if the time limit laid down in Rule 70(1) EPC (i.e. six months after publication of the international search report) has expired before the 31-month period pursuant to Rule 159(1) EPC (R. 159(1)(f) EPC);

   f) Pay the renewal fee in respect of the third year, if the fee has fallen due (see Rule 51(1) EPC) before expiry of the 31-month period pursuant to Rule 159(1) EPC (R. 159(1)(g) EPC);

   g) File, where applicable, the certificate of exhibition referred to in Article 55(2) and Rule 25 EPC (R. 159(1)(h) EPC);

   h) Pay the claims fees for the sixteenth and each subsequent claim when the application documents on which the European grant procedure is to be based comprise more than fifteen claims (R. 162(1) EPC).

If either the translation of the international application or the request for examination is not filed in due time, or if the filing fee or the search fee is not paid in due time, or no designation fee is paid in due time, the European patent application **shall be deemed to be withdrawn** (R. 160(1) EPC).

If the renewal fee is not paid in due time, it may still be paid within six months of the due date, provided that an additional fee is also paid within that period (R. 51(2) EPC).

If the claims fees are not paid in due time, they may still be paid within one month from a communication of the EPO pointing out the failure to observe the time limit (R. 162(2) EPC).

6. For an overview of search and examination fees, see the Notice from the European Patent Office dated 1 March 2006 (OJ EPO 2006, 192). The amounts of the fees are regularly published in the Official Journal of the EPO and are available on the EPO internet site at **http://www.epo.org**. At any time, payments to the EPO can be validly made by anybody.

7. If the applicant had appointed a representative during the application's international phase, the present Form will be sent to the representative, asking him to inform the applicant accordingly.

   All subsequent communications will be sent to the applicant, or if the EPO is informed of his appointment in time, to the applicant's European representative.

8. For more details about time limits and procedural acts before the EPO as designated or elected Office, see the EPO brochure "How to get an European patent", Guide for applicants - Part 2, PCT procedure before the EPO - "Euro-PCT" (EPO PCT Guide). This brochure, the list of professional representatives before the EPO, Form 1200 and details of the latest fees are available on the Internet under **http://www.epo.org**.

Receiving Section

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2006/054599

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B5/00

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, BIOSIS, COMPENDEX, EMBASE, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 111 826 A (NASIFF ROGER E [US]) 12 May 1992 (1992-05-12) column 4, lines 42-50 column 7, paragraph 2	1-21
X	EP 1 254 629 A1 (OMRON TATEISI ELECTRONICS CO [JP] OMRON HEALTHCARE CO LTD [JP]) 6 November 2002 (2002-11-06) paragraphs [0052] - [0056], [0070]	1-21
A	US 2003/065257 A1 (MAULT JAMES R [US] ET AL) 3 April 2003 (2003-04-03) abstract	1-21

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the International search	Date of mailing of the international search report
21 June 2007	02/07/2007

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Clevorn, Jens

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2006/054599

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 5111826	A	12-05-1992	NONE		
EP 1254629	A1	06-11-2002	AT	320754 T	15-04-2006
			CN	1400882 A	05-03-2003
			DE	60118236 T2	01-03-2007
			WO	0239893 A1	23-05-2002
			US	2004077958 A1	22-04-2004
US 2003065257	A1	03-04-2003	CA	2397133 A1	26-07-2001
			EP	1250085 A2	23-10-2002
			JP	2004509652 T	02-04-2004
			WO	0152718 A2	26-07-2001
			US	2001049470 A1	06-12-2001

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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International Bureau

PCT

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05112250.5 15 December 2005 (15.12.2005) EP

(71) Applicant *(for all designated States except US)*: **KONINKLIJKE PHILIPS ELECTRONICS N.V.** [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

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(75) Inventors/Applicants *(for US only)*: **GORIS, Annelies** [NL/NL]; c/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). **BODLAENDER, Maarten, P.** [NL/NL]; c/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

(74) Agents: **DAMEN, Daniel, M.** et al.; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

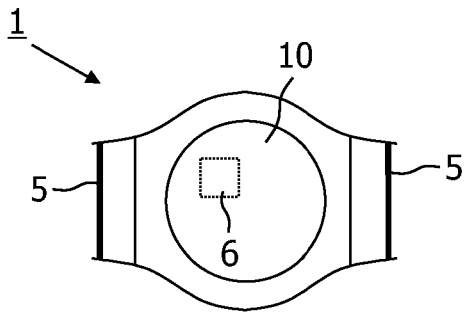
Declaration under Rule 4.17:
— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:
— *with international search report*

(88) Date of publication of the international search report:
18 October 2007

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: DETECTION AND COMPENSATION METHOD FOR MONITORING THE PLACE OF ACTIVITY ON THE BODY



(57) Abstract: A measuring system (1) comprises a sensor (6) arranged to be attached to a subject for obtaining a measured value representing a physical or a physiological quantity of the subject. The measuring system further comprises means for deriving a subject-related value from the measured value. The sensor is arranged to be attached at one of a plurality of positions on the subject. The measuring system further comprises means for establishing the position of the sensor on the subject. The means for deriving the subject-related value is arranged for deriving the subject-related value also in dependence on the position of the sensor on the subject.

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International application number: PCT/IB2006/054599

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Document details: Country/Office: EP
Number: 05112250.5
Filing date: 15 December 2005 (15.12.2005)

Date of receipt at the International Bureau: 07 December 2006 (07.12.2006)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)

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003603

IB/06/54599

Bescheinigung / Certificate / Attestation

Die angehefteten Unterlagen stimmen mit der ursprünglich eingereichten Fassung der auf dem nächsten Blatt bezeichneten europäischen Patentanmeldung überein.

The attached documents are exact copies of the European patent application described on the following page, as originally filed.

Les documents fixés à cette attestation sont conformes à la version initialement déposée de la demande de brevet européen spécifiée à la page suivante.

Patentanmeldung Nr. / Patent application No. / Demande de brevet n°

05112250.5 / EP05112250

The organization code and number of your priority application, to be used for filing abroad under the Paris Convention, is EP05112250

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le President de l'Office européen des brevets
p.o.

R.C. van Dijk

Europäisches Patentamt
GD1

European Patent Office
DG1

Office européen des brevets
DG1

Anmeldung Nr:
Application no.: 05112250.5
Demande no:

Anmeldetag:
Date of filing: 15.12.05
Date de dépôt:

Anmelder/Applicant(s)/Demandeur(s):

Koninklijke Philips Electronics N.V.
Groenewoudseweg 1
5621 BA Eindhoven/NL

Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

Detection and compensation method for place of activity monitor on the body

In anspruch genommene Priorität(en) / Priority(ies) claimed / Priorité(s) revendiquée(s)
Staat/Tag/Aktenzeichen / State/Date/File no. / Pays/Date/Numéro de dépôt:

Internationale Patentklassifikation / International Patent Classification / Classification internationale de brevets:

A61B5/00

Am Anmeldetag benannte Vertragstaaten / Contracting states designated at date of filing / Etats contractants désignées lors du dépôt:

AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR

Detection and compensation method for place of activity monitor on the body

FIELD OF THE INVENTION

The invention relates to a measuring system (1) comprising

- a sensor (6) arranged to be attached to a subject for obtaining a measured value representing a physical or a physiological quantity of the subject, and
- means for deriving a derived value relating to the subject from the measured value.

The invention also relates to a system for determining the calorie balance of a subject, and to a method for estimating a derived value relating to a subject.

BACKGROUND OF THE INVENTION

Overweight and obesity are growing problems, for example over 60% of the American population can be classified as overweight or obese. Weight gain occurs when a human has a higher energy intake (food) than energy expenditure (resting metabolic rate + activity). Since this misbalance causes the weight gain problem, many weight loss programs require that users log the food consumed and activities done in order to estimate the calorie balance.

Tables and equations exist for converting nutrition values and activities into calorie intake and expenditure, respectively. However, manual calorie counting is a cumbersome process requiring knowledge, time, effort, recording and discipline. Thus, calorie logging is a problem for many people and hence it is a challenge for researchers to find a solution therefore.

In US patent application publication US2003/0065257, a combination of a diet and activity-monitoring device is described for monitoring both the consumption and activity of the subject. Such a monitoring device includes a body activity monitor for monitoring the body activity of the subject. The body activity monitor is operable to output a signal indicative of the subject's body activity. An activity calculator may also be provided, which receives the activity indicative signal and determines body activity level and/or energy expenditure for the subject. The monitoring device may take the form of a wristwatch-style device or a belt or clothing-mounted monitor. The monitoring device may comprise a heart

rate monitor. The heart rate of the subject increases with activity and decreases when the subject is resting. The activity monitor may be calibrated using an indirect calorimeter. The heart rate sensor may be part of the wristwatch-style activity monitor, or it may be provided as a separate unit, for example in the form of a chest-strap, that communicates with the activity monitor.

The activity monitor may alternatively comprise a motion sensor such as a mechanical pendulum or a single or multi-axis accelerometer. An accelerometer is preferred since it may provide information on body movement as well as the direction and intensity of the movement. The motion sensor may form part of the wristwatch or belt or clothing mounted monitoring device or may be part of a separate accessory that communicates with the monitoring device. The body activity monitor may be calibrated to determine activity related energy expenditure using an indirect calorimeter.

As another alternative, the body activity monitor may include multiple modes for recording a variety of activities, such as swimming, biking, and use of stationary exercise equipment. The subject presses a start button and the body activity monitor will record the duration of the activity.

Furthermore, the monitoring device also preferably includes a consumption notation control for use by the subject to indicate when the subject consumes food. The body activity monitor and the consumption notation control can take a variety of forms. It can include a GPS antenna to determine the position of the subject using GPS signals. It can combine a time-indicative signal with the GPS signals to determine changes in position of the subject as well as the rate of change in position. This allows determination of movement or body activity. The device may be calibrated to determine caloric expenditure from the measured body activity.

Moreover, a position and/or activity discriminator can be included in or communicating with the body activity monitor. The discriminator functions to determine the position and/or activity of the subject by determining the proximity of the subject to various devices and locations, such as exercise equipment and buildings. For example, it may be determined that the subject is close to running shoes to discriminate the activity of running. In a more advanced configuration, proximity to running shoes may be combined with GPS signals, heart rate sensor and/or motion sensor output to allow the activity calculator to determine the type of activity being performed, the duration of the activity, and the intensity of the activity.

When the user first uses the system, he or she may designate certain movement patterns as correlating with certain activities. This will aid in calibrating the activity monitor.

Each of the described activity monitors and sensors are designed to be placed on a single position on the body. Bodily signals such as acceleration and ECG signals, are measured local to the position where the sensor is attached to the object. For example, acceleration measured by an accelerometer at the wrist includes motion of the arm, which is not detected by an accelerometer mounted at the waist.

The existing activity monitors, including for example a wrist strap or a waist belt, are often designed to be worn on one place on the body. The existing activity monitor is calibrated such that it provides accurate results if it is attached to a predefined location on the body. If the activity monitor is attached to a different location, the measured activity may be less accurate. If the activity monitor is not attached to the reference position, errors exceeding 5% in the estimation of energy expenditure may occur. This amounts to an error exceeding approximately 100 kilocalories per day.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a measurement system that provides a more accurate estimate of a parameter relating to a subject.

According to the invention, this object is realized in that

- the sensor is arranged to be attached to one of a plurality of positions on the subject,

- the measuring system further comprises means for establishing the position of the sensor on the subject, and

- the means for deriving the derived value is arranged for deriving the derived value also in dependence on the position of the sensor on the subject.

With these provisions, the accuracy of the derived value is guaranteed for any of a plurality of positions on the body. The subject can attach the sensor to any preferred position on the body, and can preferably attach it to a different position whenever he or she desires to do so.

Subjects may have different preferences where they prefer to wear the sensor, and the same subject may prefer to wear the sensor at different locations, depending on for example the location of the subject, the local weather, or the activity the subject is performing at any given time. Advantageously, a plurality of sensors are attached to different

positions on the subject and the means for deriving the derived value is arranged for combining the respective obtained measured values in order to increase the accuracy of the derived value.

The invention is particularly suitable for determining a derived value relating to a human or an animal.

According to an aspect of the invention, the plurality of positions includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head. This allows for an especially flexible use of the activity monitor, because the mentioned positions are especially well suited for measuring the activity of the subject, and they are particularly convenient for wearing a sensor device.

According to another aspect of the invention, the derived value comprises an activity parameter of the subject. With this aspect, the measuring system becomes an activity monitor that enables to monitor the degree of activity performed by the subject. Other possible derived values include a temperature value or an ECG value that is automatically compensated for the location of the sensor. Advantageously, the position of the sensor on the subject is established in dependence on an accelerometer measurement and a temperature or ECG value is compensated in dependence on the established position.

According to an aspect of the invention, the activity parameter comprises energy expenditure. This makes the activity monitor particularly suitable for use in weight management.

According to another aspect of the invention, the activity parameter represents the degree of activity of the body part the sensor is attached to. When the position of the sensor on the subject is known, it becomes possible to monitor activity parameters related to a specific body part. For example, if the sensor is attached to the arm, the activity monitor can track energy expenditure, and in addition can track local acceleration of the arm. For example, with additional information provided by fitness equipment, the forces applied to the arm can be estimated and combined with acceleration information provided by the sensor to obtain local energy expenditure. This enables subjects to optimize a training schedule to train a specific body part. Also, if a predefined safety limit is exceeded, this can be provided as feedback to the user to avoid potentially dangerous situations.

According to an aspect of the invention, the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration. These examples of measured values are correlated to activity.

According to another aspect of the invention, the system further comprises means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on the position of the sensor on the subject, and the sensor is arranged for generating a further measured value for each quantity in the selected subset. The subset may contain zero or more further physical and/or physiological quantities of the subject, for example temperature, ECG, or acceleration. This aspect allows the system to generate measurements that are particularly relevant to the body part the sensor is attached to. For example, a temperature measurement may provide relevant information when the temperature sensor is attached to the trunk of the body, and not when it is attached to, for example, an ankle. The system can take this into account for example by disregarding, or compensating, temperature measurement if the sensor is attached to an ankle. Further physical and/or physiological quantities, such as heartbeat rate or temperature, can be used alongside for example a derived activity parameter in various health applications.

According to another aspect of the invention, the system further comprises

- means for converting the measured value to an estimated measured value related to a reference position on the subject, and
- means for deriving the derived value from the estimated measured value.

This aspect allows the measuring system to accurately measure, for example, an activity parameter with the sensor at one of a plurality of positions on the subject, even if the measuring system is calibrated for only a single reference position, because the deviation of the measured value caused by wearing the activity monitor at a different position is compensated for. The accuracy can be increased even further by calibrating a plurality of reference positions. In case a plurality of reference positions is calibrated, and the sensor is attached to a position that is not a reference position, the means for converting can compensate the measured value with respect to the nearest reference position or with respect to a weighted average of reference positions, thereby increasing the accuracy further.

Another aspect of the invention is characterized in that the means for determining the position of the sensor on the subject is arranged for performing the determining in dependence on the measured value. This allows the sensor to be attached to different positions on the subject, without any additional user interaction to indicate the actual position of the device.

According to another aspect of the invention, it further comprises means for obtaining from the sensor a plurality of measured values measured during a time interval, and wherein the means for determining the position of the sensor on the subject is arranged for

performing the determining in dependence on the measured values measured during the time interval. This allows for an especially reliable determining of the position of the sensor.

According to another aspect of the invention, the means for determining the position of the sensor on the subject is arranged for performing the determining on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively. A set of rules, preferably part of a rule-based system, possibly making use of fuzzy logic, is particularly suited for determining the position of the sensor.

According to another aspect of the invention, the means for determining the position of the sensor on the subject comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval. Pattern recognition means is especially favorable to achieve a high reliability in establishing the position of the sensor on the subject.

According to an aspect of the invention, it further comprises means for determining that the user is performing a standardized activity, and the means for determining the position of the sensor on the subject is arranged for using at least one measured value obtained from the sensor, the measured value relating to a time the user is performing the standardized activity. This allows the activity monitor to determine the position of the device on the body with greater certainty. Preferably, the standardized activity has a repeating pattern with a cycle time of, for example, 1 to 2 seconds and the standardized activity is performed for at least five cycles.

According to another aspect of the invention, the means for determining that the user is performing a standardized activity is arranged for performing the determining in dependence on at least one measured value. This increases the accuracy and reduces the amount of required user interaction.

Another aspect of the invention further comprises a user interface for receiving input from a user for indicating when the subject is performing the standardized activity. This allows a very economical implementation of the activity monitor.

Another aspect of the invention further comprises a user interface for receiving input from a user related to the position of the sensor on the subject. This allows a very economical implementation of the activity monitor.

Another aspect of the invention further comprises

- means for establishing that the subject is performing a predetermined activity,

- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,

- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and

- means for providing feedback in dependence on the similarity measure.

If the sensor position and the type of activity are known, the actual body movements can be compared to movements that are "optimal" for that particular activity. This translates in a measure of efficiency and proficiency in the selected activity. For example, inexperienced runners have a larger vertical acceleration component than experienced runners. Optimal movement patterns can be looked up in a database with key (desired activity, body part), and a pattern-matching technique can be used to determine how the actual pattern compares to the optimal pattern. Moreover, suggestions to change movement patterns of the specific body part can be given, such as for example, "when striking a ball with a racket, try to move in a continuous circular motion, and do not stop the motion after impact, to maximize acceleration of the ball upon impact". Alternatively, movements associated with health problems such as a baseball-arm, can be detected and feedback can be provided about the undesired movements.

According to another aspect of the invention, the means for establishing that the subject is performing the predetermined activity is arranged for establishing that the subject is performing at least one of a predetermined number of predetermined activities. This allows the activity monitor to distinguish between a pluralities of activities of the subject, so that feedback can be provided in relation to the established activity.

According to another aspect of the invention, it further comprises a further sensor arranged to be attached to the subject for obtaining a further measured value representing a further physical or physiological quantity of the subject, and wherein the means for deriving the derived value is arranged for deriving the derived value also in dependence on the further measured value. Advantageously, a plurality of sensors are attached to different positions on the subject and the means for deriving the derived value is arranged for combining the respective obtained measured values in order to increase the accuracy of the derived value. Advantageously, the sensors communicate with each other or with a central unit, for example by means of a wireless or wired connection, for coordinated processing of the obtained measured values.

The system for determining the calorie balance of a subject according to the invention is characterized in comprising the activity monitor set forth, means for monitoring

food consumption, and means for deriving the calorie balance using the derived energy expenditure. This system can provide accurate calorie balance because the activity parameter is determined with a high degree of accuracy.

The method according to the invention is characterized in that

- the method further comprises the step of determining the position of the sensor on the subject, and
- the step of deriving the derived value is performed also in dependence on the position of the sensor on the subject.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the method of the invention will be further elucidated and described with reference to the drawing, in which:

Figures 1 A,B,C,D show sketches of a device with attachment means that can be attached to several positions on a subject.

Figure 2 shows an activity monitor with user interface.

Figure 3 shows an activity monitor comprising a device with a sensor connected to a separate unit by means of a wireless link.

Figure 4 shows a diagram of an embodiment of the method according to the invention.

Figures 5 A,B show diagrams of embodiments of the measurement method according to the invention including the compensation method according to the invention.

Figure 6 shows a diagram of an embodiment of the method according to the invention including the method according to the invention to determine the position of the sensor on the subject.

Figure 7 shows a diagram of an embodiment of the method according to the invention including the compensation initialization method according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1A shows an activity monitor 1 comprising a sensor 6 (shown in dotted lines), a display 10, and strap attachment means 5. The activity monitor 1 further comprises a microprocessor (not shown) for computing and displaying an activity parameter. The sensor 6 can comprise a single-axial or multi-axial accelerometer, a temperature sensor, an electrical sensor for measuring electrical body signals such as the ECG signal, a heart rate sensor, a pedometer, a global or local positioning system, or any other type of sensor. Such sensors are

known to the skilled artisan. Figure 1B shows the activity monitor 1, fixed to a short strap 2 with a buckle 4, and Figure 1C shows the activity monitor 1 fixed to a long strap 3. The short strap 2 is suitable for attaching the activity monitor to a wrist or ankle, while the long strap 3 is suitable for attaching the activity monitor to a waist or chest. Figure 1D shows a side view of the activity monitor illustrating a clip 9 fixed to the back of the activity monitor, enabling the possibility to attach the activity monitor to clothing. The activity monitor with accessories as shown can be attached to one of a plurality of positions on a subject. The display 10 can be a touch-screen display for having a subject provide input to the activity monitor.

Figure 2 shows an activity monitor 20 with at least one button 21,22, a display 23, and a sensor 24. The button can be used for receiving input from a user. Preferably, more buttons are provided to make it easier for the subject to provide different kinds of input to the activity monitor.

Figure 3 shows an activity monitor comprising a device 30 with a sensor 33. The device 30 does not have any buttons or display. The device 30 has means to communicate with a separate unit 31, preferably using a wireless link 32 such as WIFI or Bluetooth. The separate unit 31 is used to control the device 30. The separate unit 31, for example a personal computer or a personal digital assistant, comprises a microprocessor (not shown) for processing the information gathered by the device 30 by means of sensor 33. The separate unit 31 further comprises means to receive user input and to communicate the processed information to a user.

Figure 4 shows an embodiment of the method according to the invention for activity monitoring applicable to the case that the sensor 6 is attached to a reference position. In step 100, the sensor 6 delivers a measurement value at the reference position. Preferably, the sensor 6 is a tri-axial accelerometer, and the measurement value is a triple containing acceleration information in X, Y, and Z-direction. In step 101, the activity monitor computes the corresponding activity parameter, for example energy expenditure. For a tri-axial accelerometer attached to the back of the waist, a method to compute the corresponding energy expenditure is disclosed in "Daily physical activity, energy expenditure and physical fitness; assessment and implications" by Guy Plasqui, Ph.D. thesis, Maastricht University, 2004, referred to hereinafter as "Plasqui". The back of the waist is near the center of the body and a tri-axial accelerometer attached thereto provides a good estimation of overall movements.

Figure 5A shows an example embodiment of the method according to the invention for activity monitoring applicable to the case that the sensor 6 is attached to a

position on the subject that is not a reference position. In step 105, the sensor 6 delivers a measurement value measured at the position it is attached to. After that, in step 106, the measurement value is compensated for the difference of the value at the position the sensor 6 is attached to and the corresponding value at the reference position. After that, in step 108, the activity parameter, in this case energy expenditure, is computed using the method to compute the corresponding energy expenditure disclosed in Plasqui. The compensation method of step 106, in a very simple version, in this embodiment can be expressed as:

$$x_{\text{corrected}} = a + bx_{\text{raw}},$$

where x_{raw} represents the measured value at the position the sensor 6 is attached to, $x_{corrected}$ is the corrected measured value, and a and b are compensation constants that have been stored in a compensation database 107 as part of an initialization procedure. In a multivariate system, where the measurement value comprises a tuple, for example the X, Y, and Z-components measured by a tri-axial accelerometer, the compensation method can be expressed as:

$$x_{\text{corrected},i} = a_i + b_{i,1}x_{\text{raw},1} + b_{i,2}x_{\text{raw},2} + \cdots + b_{i,N}x_{\text{raw},N},$$

where $x_{\text{raw},1}, x_{\text{raw},2}, \ldots, x_{\text{raw},N}$ represent the N components of the measurement value tuple; $x_{\text{corrected},i}$ represents the i-th component of the corrected measurement value tuple $(x_{\text{corrected},1}, x_{\text{corrected},2}, \ldots, x_{\text{corrected},N})$, and a_i and $b_{i,j}$, for $i, j = 1, 2, \ldots, N$, are compensation constants that have been stored in a compensation database 107 as part of an initialization procedure. This example of a compensation method is particularly easy to implement. Other, potentially more flexible compensation methods are easily conceivable. Such methods include higher order polynomials, generalized linear models, other statistical methods, artificial neural networks, and fuzzy logic methods.

Figure 5B shows an alternative embodiment of the method according to the invention for activity monitoring applicable to the case that the sensor 6 is attached to a position on the subject that is not a reference position. In step 110, the sensor 6 delivers a measurement value measured at the position it is attached to. After that, in step 111, the activity parameter, in this case energy expenditure, is computed using the method to compute the corresponding energy expenditure disclosed in Plasqui. Finally, in step 112 the computed energy expenditure is compensated for the difference of the energy expenditure as computed from the value measured at the position the sensor 6 is attached to and the "real" energy expenditure, that would have been obtained if the sensor had been attached to the reference

position. The compensation method, which is similar to the compensation method appearing in the embodiment according to Figure 5A, makes use of the information stored in the compensation database 113.

Figure 6 shows a diagram of an embodiment of a method to determine the position on the subject the sensor 6 is attached to and to compute the activity parameter, regardless of where the sensor was attached. In step 115, the measured value or a sequence of measured values are obtained from the sensor 6. Next, the position on the body is determined in step 116, using information from a feature database 117. To determine the position of the sensor 6 on the body, the signal from the sensor is analyzed for features that are position-dependent. Also, the subject is instructed to perform predefined standardized activities, such as walking, sitting, and standing, preferably for about 20 seconds each. Alternatively, the user can provide input to the activity monitor to indicate when he or she performs a standardized activity, and possibly, which standardized activity he or she performs. Combinations of the values during the standardized activities or the absolute measured values are used to determine the position of the sensor 6 on the subject. Thereto, a number of predefined rules are used. These rules can be in the form of "if...then" rules. An example of such a rule is: "if the measured value during walking is in the range of *A* to *B* times higher than during sitting, the sensor 6 is positioned on the lower arm", where *A* and *B* are constants stored in the feature database 117. Another example of such a rule is: "if the measured value during walking is in the range of *C* to *D*, the sensor 6 is positioned on the leg", where *C* and *D* are constants stored in the feature database 117. The rules can also be implemented in terms of fuzzy logic rules. Other ways to provide a set of rules, including for example neural network methods and logic programming, are obvious to the skilled artisan. In a preferred embodiment, the position of the sensor 6 on the subject is determined by means of pattern recognition. The pattern recognition can be performed for example by correlating a signal obtained from the sensor with a signal stored in the feature database 117. The pattern recognition can be performed in the time domain, the frequency domain, or another domain, preferably a time-frequency domain such as a wavelet domain. Pattern recognition can be performed in many ways known to the skilled artisan. For example, techniques used in speech recognition can be applied.

After the position of the sensor 6 on the subject has been determined in step 116, and the position is not a reference position (step 118, branch 122), in step 119 the measured value is compensated for the difference between the value at the position the sensor is attached to and the corresponding value at a reference position, making use of the

information in a compensation database 120, in a way similar to the embodiment according to Figure 5A. Finally, in step 121 the activity parameter is computed from the, possibly compensated, measured value, in a way similar to the embodiment according to Figure 5.

In another embodiment, the measured value is first converted to an activity parameter, and the activity parameter is used to determine the position of the sensor 6 on the subject in a way similar to what is described above. In that case, after the position has been determined, the computed activity parameter is compensated for the difference between the computed activity parameter and the corresponding activity parameter computed from a value measured at a reference position, making use of information stored in a compensation database, in a way similar to the embodiment according to Figure 5B. It is also possible to use other quantities, relating to measured values obtained from the sensor 6, in the step to determine the position 116 and/or in the step to compensate for the difference 119.

Figure 7 shows a diagram of an embodiment of an initialization procedure for the compensation database. In this embodiment, a sequence of steps is performed iteratively. As a first step 130, i and j are both initialized to 1. Each iteration starts with step 131 comprising an instruction to the subject to perform predefined activity i. The instruction can comprise a spoken instruction to walk, sit, or stand, or it can for example comprise showing the activity on a display for a predefined duration. Then, in step 132 the subject performs the predefined activity i, while the sensor 6 attached to position j on the subject measures a physical value, in this case tri-axial acceleration, in step 133. Next, in step 134 the essential features are extracted from the measured value signal and stored in a feature database 135. These essential features may comprise decision rules or constants that are part of decision rules, similar to the constants A, B, C, and D appearing in the description of the embodiment according to Figure 6. Similarly, essential signal patterns can be stored in the time domain, frequency domain, time-frequency domain, or any other domain or combination of domains. Simultaneously, if position j is not a reference position (step 136, branch 145), in step 137 compensation parameters describing the difference between the measured value at the position of the sensor 6 on the subject and the corresponding value at a reference position are determined and stored in a compensation database 138. These compensation parameters can comprise constants appearing in the compensation method, similar to the constants a, b, a_i, and $b_{i,j}$ occurring in the description of the embodiment according to Figure 5A.

To conclude an iteration, i is increased in step 139, and if i is smaller than or equal to the number of predefined activities (step 140, branch 147), the iteration steps are

repeated; otherwise, *j* is increased in step 141, and if *j* is smaller than or equal to the predefined number of positions (step 142, branch 148), *i* is set to 1 in step 143 and the iteration steps are repeated. If *j* is greater than the predefined number of positions (step 142, branch 149), the initialization procedure is finished.

In general, this sequence could be parallelized further, for example by using a plurality of sensors 6 to measure the value at a plurality of positions on the subject simultaneously. In this embodiment, the steps of extracting compensation parameters and extracting essential signal features are performed in parallel. However, they can also be performed sequentially. In an alternative embodiment, the activity parameter is computed after the sensor 6 has delivered the signal in step 133, and before extracting essential features in step 134 and determining compensation parameters in step 137. It is also possible to compute at least one derived quantity from the values measured by the sensor 6, and perform the steps of extracting essential features and determining compensation parameters based on the derived quantity.

In another embodiment, the initialization of the compensation database and the feature database are performed on the basis of a population of subjects. All subjects are asked to perform the standardized activities, the measured values are obtained from the sensor 6 at multiple positions on the subject, and after the data of all subjects has been collected and stored in an intermediate database, the compensation database and the feature database are filled with values that are representative for the population. This embodiment has the advantage that the activity monitor needs to be initialized only once, possibly by the manufacturer, and after that an unlimited number of activity monitors can be produced using the same database values.

It will be appreciated that the invention also extends to computer programs, particularly computer programs on or in a carrier, adapted for putting the invention into practice. The program may be in the form of source code, object code, a code intermediate source and object code such as partially compiled form, or in any other form suitable for use in the implementation of the method according to the invention. The carrier may be any entity or device capable of carrying the program. For example, the carrier may include a storage medium, such as a ROM, for example a CD ROM or a semiconductor ROM, or a magnetic recording medium, for example a floppy disc or hard disk. Further the carrier may be a transmissible carrier such as an electrical or optical signal, which may be conveyed via electrical or optical cable or by radio or other means. When the program is embodied in such a signal, the carrier may be constituted by such cable or other device or means. Alternatively,

the carrier may be an integrated circuit in which the program is embedded, the integrated circuit being adapted for performing, or for use in the performance of, the relevant method.

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. Use of the verb "comprise" and its conjugations does not exclude the presence of elements or steps other than those stated in a claim. The article "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. The invention may be implemented by means of hardware comprising several distinct elements, and by means of a suitably programmed computer. In the device claim enumerating several means, several of these means may be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

CLAIMS:

1. A measuring system (1) comprising

- a sensor (6) arranged to be attached to one of a plurality of positions on a subject for obtaining a measured value representing a physical or a physiological quantity of the subject, and

- means for establishing the position of the sensor on the subject, and

- means for deriving a derived value relating to the subject from the measured value also in dependence on the position of the sensor on the subject.

2. The measuring system according to claim 1, wherein the plurality of positions includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head.

3. The measuring system according to claim 1, wherein the derived value comprises an activity parameter of the subject.

4. The measuring system according to claim 3, wherein the activity parameter comprises energy expenditure.

5. The measuring system according to claim 1, wherein the activity parameter represents a degree of activity of the body part the sensor is attached to.

6. The measuring system according to claim 1, wherein the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration.

7. The measuring system according to claim 1, further comprising means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on the position of the sensor on the subject, and the sensor is arranged for generating a further measured value for each quantity in the selected subset.

8. The measuring system according to claim 1, further comprising

- means for converting the measured value to an estimated measured value related to a reference position on the subject, and

- means for deriving the derived value from the estimated measured value.

9. The measuring system according to claim 1, wherein the means for determining the position of the sensor on the subject is arranged for performing the determining in dependence on the measured value.

10. The measuring system according to claim 9, further comprising means for obtaining from the sensor a plurality of measured values measured during a time interval, and wherein the means for determining the position of the sensor on the subject is arranged for performing the determining in dependence on the measured values measured during the time interval.

11. The measuring system according to claim 9 or 10, wherein the means for determining the position of the sensor on the subject is arranged for performing the determining on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively.

12. The measuring system according to claim 10, wherein the means for determining the position of the sensor on the subject comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval.

13. The measuring system according to claim 9 or 10, further comprising means for determining that the user is performing a standardized activity, and wherein the means for determining the position of the sensor on the subject is arranged for using at least one measured value obtained from the sensor, the measured value relating to a time the user is performing the standardized activity.

14. The measuring system according to claim 13, wherein the means for determining that the user is performing a standardized activity is arranged for performing the determining in dependence on at least one measured value.

15. The measuring system according to claim 13, further comprising a user interface for receiving input from a user for indicating when the subject is performing the standardized activity.

16. The measuring system according to claim 1, further comprising a user interface for receiving input from a user related to the position of the sensor on the subject.

17. The measuring system according to claim 1, further comprising

- means for establishing that the subject is performing a predetermined activity,

- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,

- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and

means for providing feedback in dependence on the similarity measure.

18. The measuring system according to claim 17, wherein the means for establishing that the subject is performing the predetermined activity is arranged for establishing that the subject is performing at least one of a predetermined number of predetermined activities.

19. A measuring system according to claim 1, further comprising a further sensor arranged to be attached to the subject for obtaining a further measured value representing a further physical or physiological quantity of the subject, and wherein the means for deriving the derived value is arranged for deriving the derived value also in dependence on the further measured value.

20. A system for determining the calorie balance of a subject, the system comprising the measuring system according to claim 4, means for monitoring food

consumption, and means for deriving the calorie balance using the derived energy expenditure.

21. A method for estimating a derived value relating to a subject, comprising

- obtaining at least one measured value from a sensor (6) attached to the subject, the measured value representing a physical or a physiological quantity of the subject, and

- establishing the position of the sensor on the subject, and

- deriving the derived value from the measured value also in dependence on the position of the sensor on the subject.

ABSTRACT:

A measuring system (1) comprises a sensor (6) arranged to be attached to a subject for obtaining a measured value representing a physical or a physiological quantity of the subject. The measuring system further comprises means for deriving a derived value relating to the subject from the measured value. The sensor is arranged to be attached to one of a plurality of positions on the subject. The measuring system further comprises means for establishing the position of the sensor on the subject. The means for deriving the derived value is arranged for deriving the derived value also in dependence on the position of the sensor on the subject.

Figure 1A.

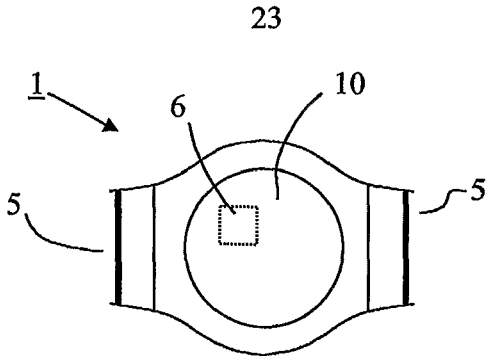


FIG. 1A

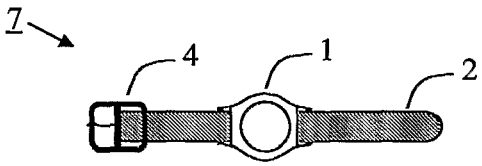


FIG. 1B

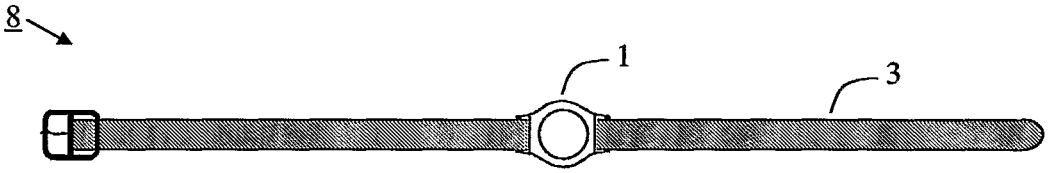


FIG. 1C

FIG. 1D

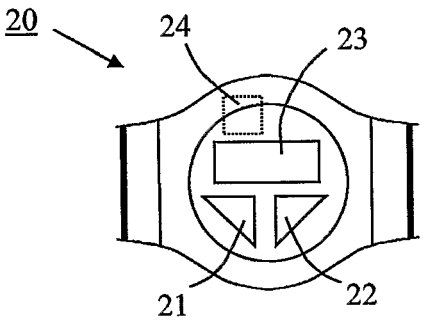


FIG. 2

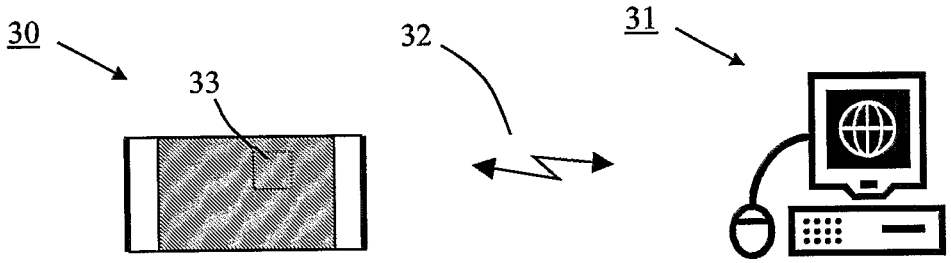


FIG. 3

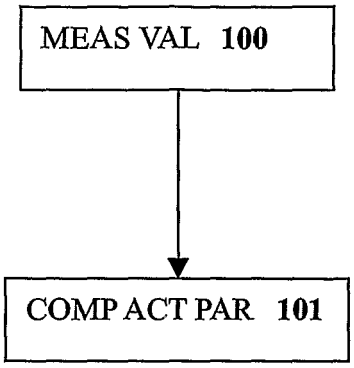


FIG. 4

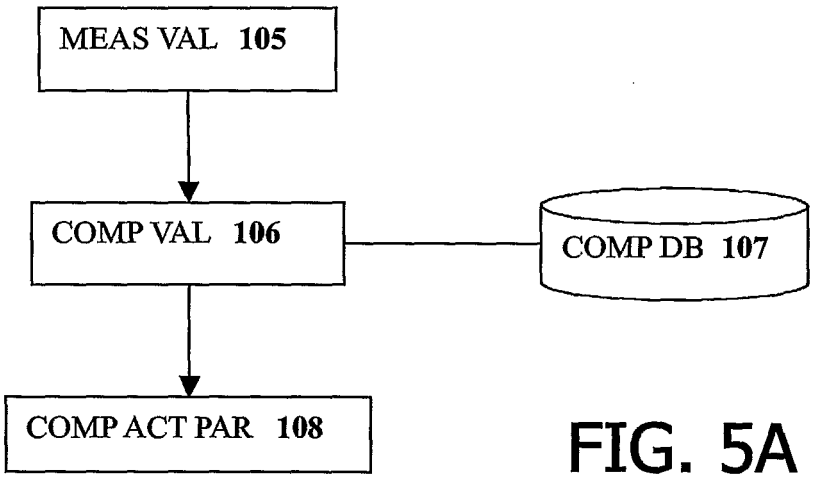


FIG. 5A

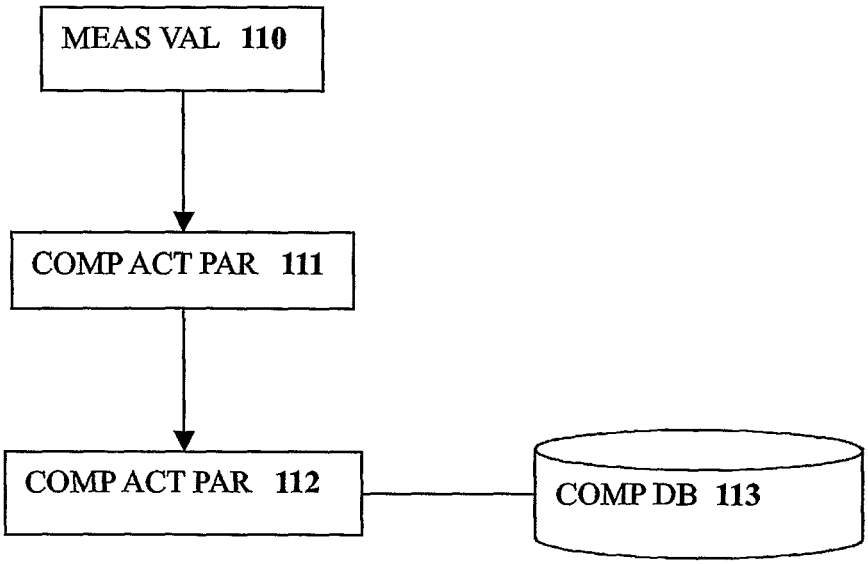
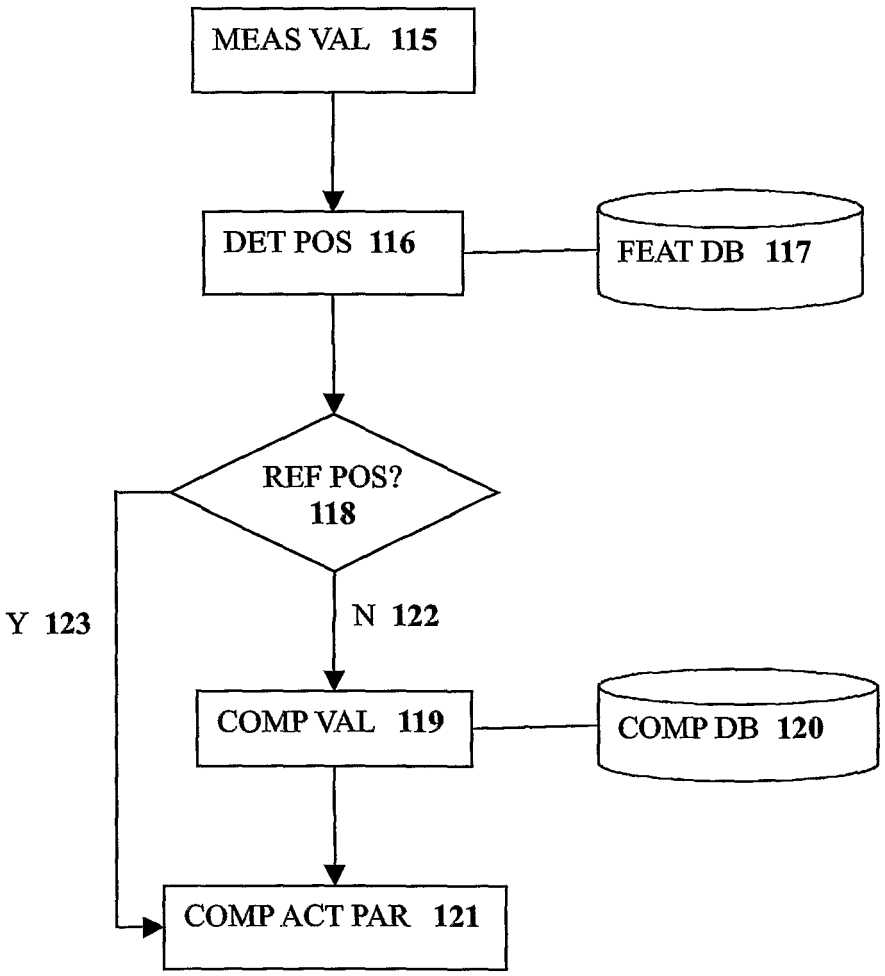


FIG. 5B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REF POS? 118
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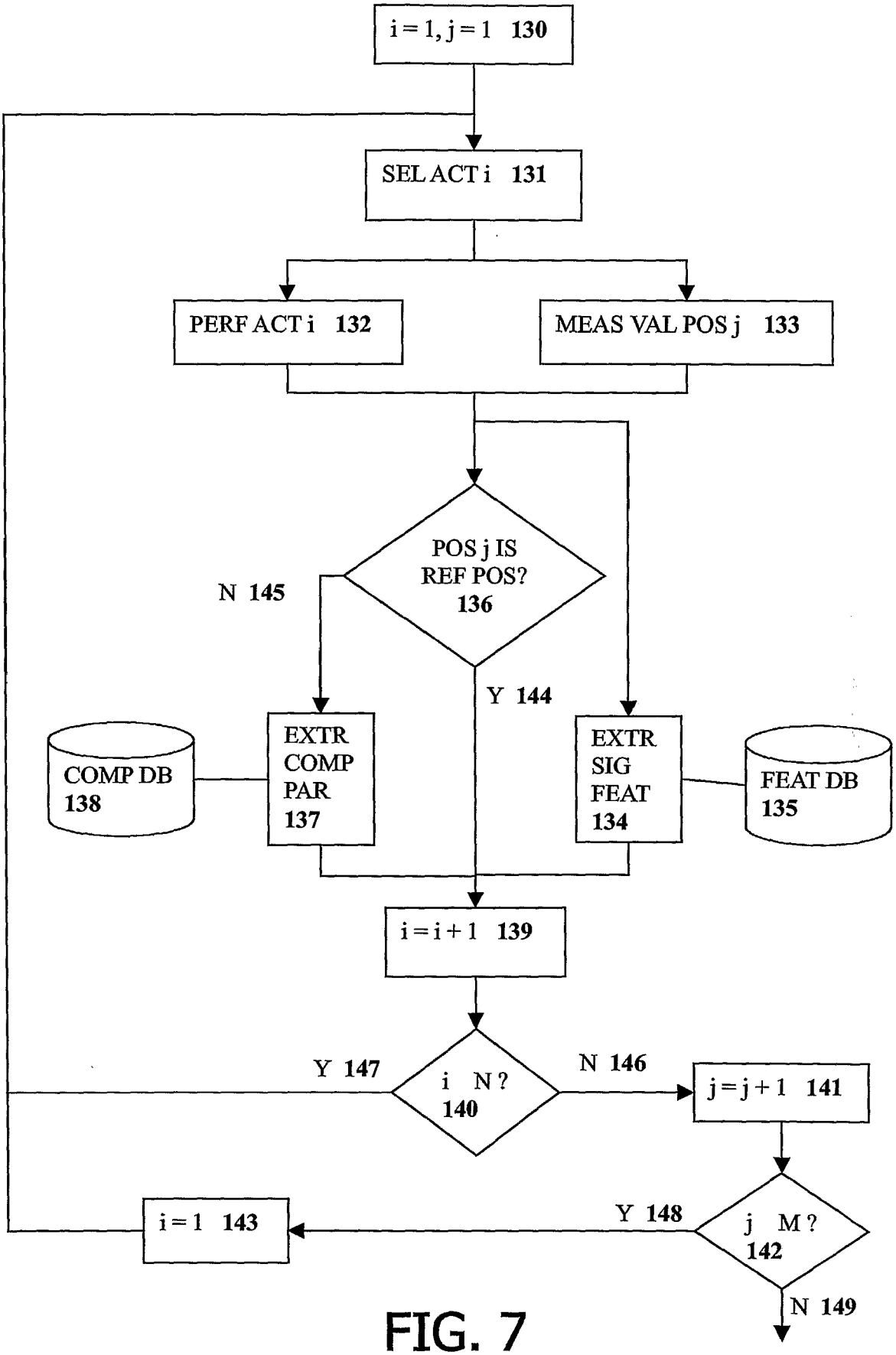
N 122
COMP VAL 119
COMP DB 120
COMP ACT PAR 121

FIG. 6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PERF ACT i 132
MEAS VAL POS j 133
POS j IS REF POS? 136
N 145
Y 144
COMP DB 138
EXTR COMP PAR 137
EXTR SIG FEAT 134
FEAT DB 135
i = i + 1 139
i N? 140
Y 147
N 146
j = j + 1 141
j M? 142
Y 148
i = 1 143
N 149

FIG. 7

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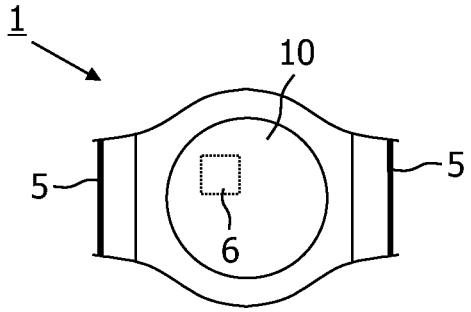
(54) **Title:** DETECTION AND COMPENSATION METHOD FOR MONITORING THE PLACE OF ACTIVITY ON THE BODY



(57) **Abstract:** A measuring system (1) comprises a sensor (6) arranged to be attached to a subject for obtaining a measured value representing a physical or a physiological quantity of the subject. The measuring system further comprises means for deriving a subject-related value from the measured value. The sensor is arranged to be attached at one of a plurality of positions on the subject. The measuring system further comprises means for establishing the position of the sensor on the subject. The means for deriving the subject-related value is arranged for deriving the subject-related value also in dependence on the position of the sensor on the subject.

WO 2007/069127 A2

Detection and compensation method for monitoring the place of activity on the body

FIELD OF THE INVENTION

The invention relates to a measuring system comprising

- a sensor arranged to be attached to a subject for obtaining a measured value representing a physical or a physiological quantity of the subject, and
- means for deriving a subject-related value from the measured value.

The invention also relates to a system for determining the calorie balance of a subject, and to a method of estimating a subject-related derived value.

BACKGROUND OF THE INVENTION

Overweight and obesity are growing problems; for example over 60% of the American population can be classified as overweight or obese. Weight gain occurs when a human has a higher energy intake (food) than energy expenditure (resting metabolic rate + activity). Since this unbalance causes the weight gain problem, many weight loss programs require that users log the food consumed and activities done in order to estimate the calorie balance.

Tables and equations exist for converting nutrition values and activities into calorie intake and expenditure, respectively. However, manual calorie counting is a cumbersome process requiring knowledge, time, effort, recording and discipline. Thus, calorie logging is a problem for many people and hence it is a challenge for researchers to find a solution therefore.

In US patent application publication US2003/0065257, a combination of a diet and activity-monitoring device is described for monitoring both the consumption and activity of the subject. Such a monitoring device includes a body activity monitor for monitoring the body activity of the subject. The body activity monitor is operable to output a signal indicative of the subject's body activity. An activity calculator may also be provided, which receives the activity indicative signal and determines body activity level and/or energy expenditure for the subject. The monitoring device may take the form of a wristwatch-style device or a belt or clothing-mounted monitor. The monitoring device may comprise a heart rate monitor. The heart rate of the subject increases with activity and decreases when the

subject is resting. The activity monitor may be calibrated using an indirect calorimeter. The heart rate sensor may be part of the wristwatch-style activity monitor, or it may be provided as a separate unit, for example in the form of a chest-strap, which communicates with the activity monitor.

The activity monitor may alternatively comprise a motion sensor such as a mechanical pendulum or a single or multi-axis accelerometer. An accelerometer is preferred since it may provide information on body movement as well as the direction and intensity of the movement. The motion sensor may form part of the wristwatch or belt or clothing-mounted monitoring device or may be part of a separate accessory that communicates with the monitoring device. The body activity monitor may be calibrated to determine activity-related energy expenditure using an indirect calorimeter.

As another alternative, the body activity monitor may include multiple modes for recording a variety of activities, such as swimming, biking, and use of stationary exercise equipment. The subject presses a start button and the body activity monitor will record the duration of the activity.

Furthermore, the monitoring device also preferably includes a consumption notation control for use by the subject to indicate when the subject consumes food. The body activity monitor and the consumption notation control may take a variety of forms. It may include a GPS antenna to determine the position of the subject using GPS signals. It may combine a time-indicative signal with the GPS signals to determine changes in position of the subject as well as the rate of change in position. This allows determination of movement or body activity. The device may be calibrated to determine caloric expenditure from the measured body activity.

Moreover, a position and/or activity discriminator may be included in or communicating with the body activity monitor. The discriminator functions to determine the position and/or activity of the subject by determining the proximity of the subject to various devices and locations, such as exercise equipment and buildings. For example, it may be determined that the subject is close to running shoes to discriminate the activity of running. In a more advanced configuration, proximity to running shoes may be combined with GPS signals, heart rate sensor and/or motion sensor output to allow the activity calculator to determine the type of activity being performed, the duration of the activity, and the intensity of the activity.

When the user uses the system for the first time, he or she may designate certain movement patterns as correlating with certain activities. This will aid to calibrate the activity monitor.

Each of the described activity monitors and sensors is designed to be placed on a single position on the body. Bodily signals such as acceleration and ECG signals, are measured local to the position where the sensor is attached to the object. For example, acceleration measured by an accelerometer on the wrist includes motion of the arm, which is not detected by an accelerometer mounted on the waist.

The existing activity monitors, including for example a wrist strap or a waist belt, are often designed to be worn on one place on the body. The existing activity monitor is calibrated such that it provides accurate results if it is attached at a predefined location on the body. If the activity monitor is attached at a different location, the measured activity may be less accurate. If the activity monitor is not attached at the reference position, errors exceeding 5% in the estimation of energy expenditure may occur. This amounts to an error exceeding approximately 100 kilocalories per day.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a measuring system that yields a more accurate estimate of a parameter relating to a subject.

According to the invention, this object is achieved in that

- the sensor is arranged to be attached at one of a plurality of positions on the subject,

- the measuring system further comprises means for establishing the position of the sensor on the subject, and

- the means for deriving the subject-related value is arranged for deriving the subject-related value also in dependence on the position of the sensor on the subject.

With these provisions, the accuracy of the derived value is guaranteed for any of a plurality of positions on the body. The subject may attach the sensor at any preferred position on the body, and can preferably attach it at a different position whenever he or she desires to do so.

Subjects may have different preferences where they prefer wearing the sensor, and the same subject may prefer wearing the sensor at different locations, depending on for example the location of the subject, the local weather, or the activity the subject is performing at any given time. Advantageously, a plurality of sensors are attached at different

positions on the subject and the means for deriving the subject-related value is arranged for combining the respective obtained measured values in order to increase the accuracy of the derived value.

The invention is particularly suitable for determining a derived value relating to a human or an animal.

According to an aspect of the invention, the plurality of positions includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head. This allows for an especially flexible use of the activity monitor, because the positions mentioned are especially well suited for measuring the activity of the subject, and they are particularly convenient for wearing a sensor device.

According to another aspect of the invention, the derived value comprises an activity parameter of the subject. With this aspect, the measuring system becomes an activity monitor that enables to monitor the degree of activity performed by the subject. Other possible derived values include a temperature value or an ECG value that is automatically compensated for by the location of the sensor. Advantageously, the position of the sensor on the subject is established in dependence on an accelerometer measurement and a temperature or ECG value is compensated for in dependence on the established position.

According to an aspect of the invention, the activity parameter comprises energy expenditure. This makes the activity monitor particularly suitable for use in weight management.

According to another aspect of the invention, the activity parameter represents the degree of activity of the body part the sensor is attached to. When the position of the sensor on the subject is known, it becomes possible to monitor activity parameters related to a specific body part. For example, if the sensor is attached to the arm, the activity monitor can track energy expenditure, and in addition can track local acceleration of the arm. For example, with additional information provided by fitness equipment, the forces applied to the arm can be estimated and combined with acceleration information provided by the sensor to obtain local energy expenditure. This enables subjects to optimize a training schedule to train a specific body part. Also, if a predefined safety limit is exceeded, this can be provided as feedback to the user to avoid potentially dangerous situations.

According to an aspect of the invention, the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration. These examples of measured values are correlated with activity.

According to another aspect of the invention, the system further comprises means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on the position of the sensor on the subject, and the sensor is arranged for generating a further measured value for each quantity in the selected subset. The subset may contain zero or more further physical and/or physiological quantities of the subject, for example temperature, ECG, or acceleration. This aspect allows the system to generate measurements that are particularly relevant to the body part the sensor is attached to. For example, a temperature measurement may provide relevant information when the temperature sensor is attached to the trunk of the body, and not when it is attached to, for example, an ankle. The system can take this into account for example by disregarding, or compensating, temperature measurement if the sensor is attached to an ankle. Further physical and/or physiological quantities, such as heart rate or temperature, can be used alongside for example a derived activity parameter in various health applications.

According to another aspect of the invention, the system further comprises

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

This aspect allows the measuring system to accurately measure, for example, an activity parameter with the sensor at one of a plurality of positions on the subject, even if the measuring system is calibrated for only a single reference position, because the deviation of the measured value caused by wearing the activity monitor at a different position is compensated for. The accuracy may be increased even further by calibrating a plurality of reference positions. In case a plurality of reference positions is calibrated, and the sensor is attached at a position that is not a reference position, the means for converting can compensate the measured value with respect to the nearest reference position or with respect to a weighted average of reference positions, thereby increasing the accuracy further.

Another aspect of the invention is characterized in that the means for determining the position of the sensor on the subject is arranged for determining the position in dependence on the measured value. This allows the sensor to be attached at different positions on the subject, without any additional user interaction to indicate the actual position of the device.

According to another aspect of the invention, it further comprises means for obtaining from the sensor a plurality of measured values measured during a time interval, and

wherein the means for determining the position of the sensor on the subject is arranged for determining the position in dependence on the measured values measured during the time interval. This allows the position of the sensor to be determined in an especially reliable manner.

According to another aspect of the invention, the means for determining the position of the sensor on the subject is arranged for determining the position on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively. A set of rules, preferably part of a rule-based system, possibly making use of fuzzy logic, is particularly suited for determining the position of the sensor.

According to another aspect of the invention, the means for determining the position of the sensor on the subject comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval. A pattern recognition means is especially favorable to achieve a high reliability in establishing the position of the sensor on the subject.

According to an aspect of the invention, it further comprises means for determining that the user is performing a standardized activity, and the means for determining the position of the sensor on the subject is arranged for using at least one measured value obtained from the sensor, the measured value relating to a time the user is performing the standardized activity. This allows the activity monitor to determine the position of the device on the body with greater certainty. Preferably, the standardized activity has a repetition pattern with a cycle time of, for example, 1 to 2 seconds and the standardized activity is performed for at least five cycles.

According to another aspect of the invention, the means for establishing that the user is performing a standardized activity is arranged for establishing the activity in dependence on at least one measured value. This increases the accuracy and reduces the amount of required user interaction.

Another aspect of the invention further comprises a user interface for receiving input from a user for indicating when the subject is performing the standardized activity. This allows a very economical implementation of the activity monitor.

Another aspect of the invention further comprises a user interface for receiving input from a user related to the position of the sensor on the subject. This allows a very economical implementation of the activity monitor.

Another aspect of the invention further comprises

- means for establishing that the subject is performing a predetermined activity,

- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,

- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and

- means for providing feedback in dependence on the similarity measure.

If the sensor position and the type of activity are known, the actual body movements can be compared to movements that are "optimal" for that particular activity. This translates into a measure of efficiency and proficiency in the selected activity. For example, inexperienced runners have a larger vertical acceleration component than experienced runners. Optimal movement patterns can be looked up in a database with key (desired activity, body part), and a pattern-matching technique can be used to determine how the actual pattern compares to the optimal pattern. Moreover, suggestions to change movement patterns of the specific body part can be given, such as for example, "when striking a ball with a racket, try to move in a continuous circular motion, and do not stop the motion after impact, to maximize acceleration of the ball upon impact". Alternatively, movements associated with health problems such as a baseball-arm, can be detected and feedback can be provided about the undesired movements.

According to another aspect of the invention, the means for establishing that the subject is performing the predetermined activity is arranged for establishing that the subject is performing at least one of a predetermined number of predetermined activities. This allows the activity monitor to distinguish between a plurality of activities of the subject, so that feedback can be provided in relation to the established activity.

According to another aspect of the invention, it further comprises a further sensor arranged to be attached to the subject for obtaining a further measured value representing a further physical or physiological quantity of the subject, and wherein the means for deriving the subject-related value is arranged for deriving the measured value also in dependence on the further measured value. Advantageously, a plurality of sensors are attached at different positions on the subject and the means for deriving the subject-related value is arranged for combining the respective obtained measured values in order to increase the accuracy of the derived value. Advantageously, the sensors communicate with each other or with a central unit, for example by means of a wireless or wired connection, for coordinated processing of the obtained measured values.

The system for determining the calorie balance of a subject according to the invention is characterized in that it comprises the activity monitor set forth, means for monitoring food consumption, and means for deriving the calorie balance using the derived energy expenditure. This system can provide accurate calorie balance because the activity parameter is determined with a high degree of accuracy.

The method according to the invention is characterized in that

- the method further comprises the step of determining the position of the sensor on the subject, and

- the step of deriving the subject-related value is performed also in dependence on the position of the sensor on the subject.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the method of the invention will be further elucidated and described with reference to the drawing, in which:

Figs. 1 A,B,C,D show sketches of a device with attachment means that can be attached at several positions on a subject.

Fig. 2 shows an activity monitor with user interface.

Fig. 3 shows an activity monitor comprising a device with a sensor connected to a separate unit by means of a wireless link.

Fig. 4 shows a diagram of an embodiment of the method according to the invention.

Figs. 5 A,B show diagrams of embodiments of the measuring method according to the invention including the compensation method according to the invention.

Fig. 6 shows a diagram of an embodiment of the method according to the invention including the method according to the invention to determine the position of the sensor on the subject.

Fig. 7 shows a diagram of an embodiment of the method according to the invention including the compensation initialization method according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1A shows an activity monitor 1 comprising a sensor 6 (shown in dotted lines), a display 10, and strap attachment means 5. The activity monitor 1 further comprises a microprocessor (not shown) for computing and displaying an activity parameter. The sensor 6 can comprise a single-axial or multi-axial accelerometer, a temperature sensor, an electrical

sensor for measuring electrical body signals such as the ECG signal, a heart rate sensor, a pedometer, a global or local positioning system, or any other type of sensor. Such sensors are known to the skilled artisan. Figure 1B shows the activity monitor 1, fixed to a short strap 2 with a buckle 4, and Figure 1C shows the activity monitor 1 fixed to a long strap 3. The short strap 2 is suitable for attaching the activity monitor to a wrist or ankle, while the long strap 3 is suitable for attaching the activity monitor to a waist or chest. Figure 1D shows a side view of the activity monitor illustrating a clip 9 fixed to the back of the activity monitor, making it possible to attach the activity monitor to clothing. The activity monitor with accessories as shown can be attached at one of a plurality of positions on a subject. The display 10 can be a touch-screen display for having a subject provide input to the activity monitor.

Figure 2 shows an activity monitor 20 with at least one button 21,22, a display 23, and a sensor 24. The button can be used for receiving input from a user. Preferably, more buttons are provided to make it easier for the subject to provide different kinds of input to the activity monitor.

Figure 3 shows an activity monitor comprising a device 30 with a sensor 33. The device 30 does not have any buttons or display. The device 30 has means to communicate with a separate unit 31, preferably using a wireless link 32 such as WIFI or Bluetooth. The separate unit 31 is used to control the device 30. The separate unit 31, for example a personal computer or a personal digital assistant, comprises a microprocessor (not shown) for processing the information gathered by the device 30 by means of sensor 33. The separate unit 31 further comprises means for receiving user input and communicating the processed information to a user.

Figure 4 shows an embodiment of the method according to the invention for activity monitoring applicable to the case where the sensor 6 is attached at a reference position. In step 100, the sensor 6 delivers a measurement value at the reference position. Preferably, the sensor 6 is a tri-axial accelerometer, and the measurement value is a triple containing acceleration information in X, Y, and Z-direction. In step 101, the activity monitor computes the corresponding activity parameter, for example energy expenditure. For a tri-axial accelerometer attached to the back of the waist, a method to compute the corresponding energy expenditure is disclosed in “Daily physical activity, energy expenditure and physical fitness; assessment and implications” by Guy Plasqui, Ph.D. thesis, Maastricht University, 2004, referred to hereinafter as “Plasqui”. The back of the waist is near the center of the body and a tri-axial accelerometer attached thereto provides a good estimation of overall movements.

Figure 5A shows an example of embodiment of the method according to the invention for activity monitoring applicable to the case where the sensor 6 is attached at a position on the subject that is not a reference position. In step 105, the sensor 6 delivers a measurement value measured at the position where the sensor is attached. After this, in step 106, the measurement value is compensated for the difference of the value at the position the sensor 6 is attached and the corresponding value at the reference position. After this, in step 108, the activity parameter, in this case energy expenditure, is computed using the method of computing the corresponding energy expenditure disclosed in Plasqui. The compensation method of step 106, in a very simple version, in this embodiment can be expressed as:

$$x_{\text{corrected}} = a + bx_{\text{raw}},$$

where x_{raw} represents the measured value at the position where the sensor 6 is attached, $x_{\text{corrected}}$ is the corrected measured value, and a and b are compensation constants that have been stored in a compensation database 107 as part of an initialization procedure. In a multivariate system, where the measurement value comprises a tuple, for example the X, Y, and Z-components measured by a tri-axial accelerometer, the compensation method can be expressed as:

$$x_{\text{corrected},i} = a_i + b_{i,1}x_{\text{raw},1} + b_{i,2}x_{\text{raw},2} + \cdots + b_{i,N}x_{\text{raw},N},$$

where $x_{\text{raw},1}, x_{\text{raw},2}, \ldots, x_{\text{raw},N}$ represent the N components of the measurement value tuple; $x_{\text{corrected},i}$ represents the i-th component of the corrected measurement value tuple $(x_{\text{corrected},1}, x_{\text{corrected},2}, \ldots, x_{\text{corrected},N})$, and a_i and $b_{i,j}$, for $i, j = 1, 2, \ldots, N$, are compensation constants that have been stored in a compensation database 107 as part of an initialization procedure. This example of a compensation method is particularly easy to implement. Other, potentially more flexible compensation methods are easily conceivable. Such methods include higher order polynomials, generalized linear models, other statistical methods, artificial neural networks, and fuzzy logic methods.

Figure 5B shows an alternative embodiment of the method according to the invention for activity monitoring applicable to the case where the sensor 6 is attached at a position on the subject that is not a reference position. In step 110, the sensor 6 delivers a measurement value measured at the position where it is attached. After this, in step 111, the activity parameter, in this case energy expenditure, is computed using the method of computing the corresponding energy expenditure disclosed in Plasqui. Finally, in step 112 the computed energy expenditure is compensated for the difference of the energy expenditure as

computed from the value measured at the position where the sensor 6 is attached and the "real" energy expenditure that would have been obtained if the sensor had been attached at the reference position. The compensation method, which is similar to the compensation method appearing in the embodiment according to Figure 5A, makes use of the information stored in the compensation database 113.

Figure 6 shows a diagram of an embodiment of a method of determining the position on the subject where the sensor 6 is attached and of computing the activity parameter, regardless of where the sensor was attached. In step 115, the measured value or a sequence of measured values is obtained from the sensor 6. Next, the position on the body is determined in step 116, using information from a feature database 117. To determine the position of the sensor 6 on the body, the signal from the sensor is analyzed for features that are position-dependent. Also, the subject is instructed to perform predefined standardized activities, such as walking, sitting, and standing, preferably for about 20 seconds each. Alternatively, the user can provide the activity monitor with input to indicate when he or she performs a standardized activity, and possibly, which standardized activity he or she performs. Combinations of the values during the standardized activities or the absolute measured values are used to determine the position of the sensor 6 on the subject. Thereto, a number of predefined rules are used. These rules can be in the form of "if…then" rules. An example of such a rule is: "if the measured value during walking is in the range of *A* to *B* times higher than during sitting, the sensor 6 is positioned on the lower arm", where *A* and *B* are constants stored in the feature database 117. Another example of such a rule is: "if the measured value during walking is in the range of *C* to *D*, the sensor 6 is positioned on the leg", where *C* and *D* are constants stored in the feature database 117. The rules can also be implemented in terms of fuzzy logic rules. Other ways to provide a set of rules, including for example neural network methods and logic programming, are obvious to the skilled artisan. In a preferred embodiment, the position of the sensor 6 on the subject is determined by means of pattern recognition. The pattern recognition can be performed for example by correlating a signal obtained from the sensor with a signal stored in the feature database 117. The pattern recognition can be performed in the time domain, the frequency domain, or another domain, preferably a time-frequency domain such as a wavelet domain. Pattern recognition can be performed in many ways known to the skilled artisan. For example, techniques used in speech recognition can be applied.

After the position of the sensor 6 on the subject has been determined in step 116, and the position is not a reference position (step 118, branch 122), in step 119 the

measured value is compensated for by the difference between the value at the position at which the sensor is attached and the corresponding value at a reference position, making use of the information in a compensation database 120, in a way similar to the embodiment according to Figure 5A. Finally, in step 121 the activity parameter is computed from the, possibly compensated, measured value, in a way similar to the embodiment according to Figure 5.

In another embodiment, the measured value is first converted to an activity parameter, and the activity parameter is used to determine the position of the sensor 6 on the subject in a way similar to what is described above. In that case, after the position has been determined, the computed activity parameter is compensated for the difference between the computed activity parameter and the corresponding activity parameter computed from a value measured at a reference position, while information stored in a compensation database is made use of in a way similar to the embodiment according to Figure 5B. It is also possible to use other quantities relating to measured values obtained from the sensor 6, in the step to determine the position 116 and/or in the step to compensate for the difference 119.

Figure 7 shows a diagram of an embodiment of an initialization procedure for the compensation database. In this embodiment, a sequence of steps is performed iteratively. As a first step 130, i and j are both initialized to 1. Each iteration starts with step 131 comprising an instruction to the subject to perform predefined activity i. The instruction can comprise a spoken instruction to walk, sit, or stand, or it can for example comprise showing the activity on a display for a predefined duration. Then, in step 132 the subject performs the predefined activity i, while the sensor 6 attached at position j on the subject measures a physical value, in this case tri-axial acceleration, in step 133. Next, in step 134 the essential features are extracted from the measured value signal and stored in a feature database 135. These essential features may comprise decision rules or constants that are part of decision rules, similar to the constants A, B, C, and D appearing in the description of the embodiment according to Figure 6. Similarly, essential signal patterns can be stored in the time domain, frequency domain, time-frequency domain, or any other domain or combination of domains. Simultaneously, if position j is not a reference position (step 136, branch 145), in step 137 compensation parameters describing the difference between the measured value at the position of the sensor 6 on the subject and the corresponding value at a reference position are determined and stored in a compensation database 138. These compensation parameters may

comprise constants appearing in the compensation method, similar to the constants a, b, a_i, and $b_{i,j}$ occurring in the description of the embodiment according to Figure 5A.

To conclude an iteration, i is increased in step 139, and if i is smaller than or equal to the number of predefined activities (step 140, branch 147), the iteration steps are repeated; otherwise, j is increased in step 141, and if j is smaller than or equal to the predefined number of positions (step 142, branch 148), i is set to 1 in step 143 and the iteration steps are repeated. If j is greater than the predefined number of positions (step 142, branch 149), the initialization procedure is finished.

In general, this sequence could be paralleled further, for example by using a plurality of sensors 6 to measure the value at a plurality of positions on the subject simultaneously. In this embodiment, the steps of extracting compensation parameters and extracting essential signal features are performed in parallel. However, they can also be performed sequentially. In an alternative embodiment, the activity parameter is computed after the sensor 6 has delivered the signal in step 133, and before extracting essential features in step 134 and determining compensation parameters in step 137. It is also possible to compute at least one derived quantity from the values measured by the sensor 6, and perform the steps of extracting essential features and determining compensation parameters based on the derived quantity.

In another embodiment, the initialization of the compensation database and the feature database are performed on the basis of a population of subjects. All subjects are asked to perform the standardized activities, the measured values are obtained from the sensor 6 at multiple positions on the subject, and after the data of all subjects have been collected and stored in an intermediate database, the compensation database and the feature database are filled with values that are representative of the population. This embodiment has the advantage that the activity monitor needs to be initialized only once, possibly by the manufacturer, and after that an unlimited number of activity monitors can be produced using the same database values.

It will be appreciated that the invention also extends to computer programs, particularly computer programs on or in a carrier, adapted for putting the invention into practice. The program may be in the form of source code, object code, a code intermediate source and object code such as partially compiled form, or in any other form suitable for use in the implementation of the method according to the invention. The carrier may be any entity or device capable of carrying the program. For example, the carrier may include a

storage medium, such as a ROM, for example a CD ROM or a semiconductor ROM, or a magnetic recording medium, for example a floppy disc or hard disk. Further, the carrier may be a transmissible carrier such as an electrical or optical signal, which may be conveyed via electrical or optical cable or by radio or other means. When the program is embodied in such a signal, the carrier may be constituted by such cable or other device or means. Alternatively, the carrier may be an integrated circuit in which the program is embedded, the integrated circuit being adapted for performing, or for use in the performance of, the relevant method.

A measuring system comprises a sensor arranged to be attached to a subject for obtaining a measured value representing a physical or a physiological quantity of the subject. The measuring system further comprises means for deriving a subject-related value from the measured value. The sensor is arranged to be attached at one of a plurality of positions on the subject. The measuring system further comprises means for establishing the position of the sensor on the subject. The means for deriving the subject-related value is arranged for deriving the subject-related value also in dependence on the position of the sensor on the subject.

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. Use of the verb "to comprise" and its conjugations does not exclude the presence of elements or steps other than those stated in a claim. The article "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. The invention may be implemented by means of hardware comprising several distinct elements, and by means of a suitably programmed computer. In the device claim enumerating several means, several of these means may be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

CLAIMS:

1. A measuring system (1) comprising

- a sensor (6) arranged to be attached at one of a plurality of positions on a subject for obtaining a measured value representing a physical or a physiological quantity of the subject, and

- means for establishing the position of the sensor on the subject, and

- means for deriving a subject-related value from the measured value also in dependence on the position of the sensor on the subject.

2. The measuring system (1) according to claim 1, wherein the plurality of positions includes at least two of the following: a wrist, a lower arm, an upper arm, a lower leg, an upper leg, a waist, a chest, a neck, a head.

3. The measuring system (1) according to claim 1, wherein the derived value comprises an activity parameter of the subject.

4. The measuring system (1) according to claim 3, wherein the activity parameter comprises energy expenditure.

5. The measuring system (1) according to claim 1, wherein the activity parameter represents a degree of activity of the body part the sensor is attached to.

6. The measuring system (1) according to claim 1, wherein the measured value comprises at least one of temperature, ECG, or acceleration, in particular tri-axial acceleration.

7. The measuring system (1) according to claim 1, further comprising means for selecting a subset of a predefined set of further physical and/or physiological quantities of the subject in dependence on the position of the sensor on the subject, and the sensor is arranged for generating a further measured value for each quantity in the selected subset.

8. The measuring system (1) according to claim 1, further comprising

- means for converting the measured value into an estimated measured value related to a reference position on the subject, and

- means for deriving the subject-related value from the estimated measured value.

9. The measuring system (1) according to claim 1, wherein the means for determining the position of the sensor on the subject is arranged for performing the determining in dependence on the measured value.

10. The measuring system (1) according to claim 9, further comprising means for obtaining from the sensor (6) a plurality of measured values measured during a time interval, and wherein the means for determining the position of the sensor on the subject is arranged for performing the determining in dependence on the measured values measured during the time interval.

11. The measuring system (1) according to claim 9 or 10, wherein the means for determining the position of the sensor (6) on the subject is arranged for performing the determining on the basis of a predefined set of rules related to the measured value or measured values measured during the time interval, respectively.

12. The measuring system (1) according to claim 10, wherein the means for determining the position of the sensor (6) on the subject comprises means for performing a pattern recognition of a signal derived from the measured values measured during the time interval.

13. The measuring system (1) according to claim 9 or 10, further comprising means for determining that the user is performing a standardized activity, and wherein the means for determining the position of the sensor on the subject is arranged for using at least one measured value obtained from the sensor (6), the measured value relating to a time the user is performing the standardized activity.

14. The measuring system (1) according to claim 13, wherein the means for determining that the user is performing a standardized activity is arranged for performing the determining in dependence on at least one measured value.

15. The measuring system (1) according to claim 13, further comprising a user interface for receiving input from a user to indicate when the subject is performing the standardized activity.

16. The measuring system (1) according to claim 1, further comprising a user interface for receiving input from a user related to the position of the sensor on the subject.

17. The measuring system (1) according to claim 1, further comprising

- means for establishing that the subject is performing a predetermined activity,
- storage means for storing at least one pattern related to performing the predetermined activity in a predetermined manner,
- means for determining a similarity measure relating to a signal representing the derived value and the stored pattern, and
- means for providing feedback in dependence on the similarity measure.

18. The measuring system (1) according to claim 17, wherein the means for establishing that the subject is performing the predetermined activity is arranged for establishing that the subject is performing at least one of a predetermined number of predetermined activities.

19. A measuring system (1) according to claim 1, further comprising a further sensor arranged to be attached to the subject for obtaining a further measured value representing a further physical or physiological quantity of the subject, and wherein the means for deriving the subject-related value is arranged for deriving the measured value also in dependence on the further measured value.

20. A system for determining the calorie balance of a subject, the system comprising the measuring system (1) according to claim 4, means for monitoring food

consumption, and means for deriving the calorie balance using the derived energy expenditure.

21. A method of estimating a derived value relating to a subject, the method comprising

- obtaining at least one measured value from a sensor (6) attached to the subject, the measured value representing a physical or a physiological quantity of the subject, and

- establishing the position of the sensor on the subject, and

- deriving the subject-related value from the measured value also in dependence on the position of the sensor on the subject.

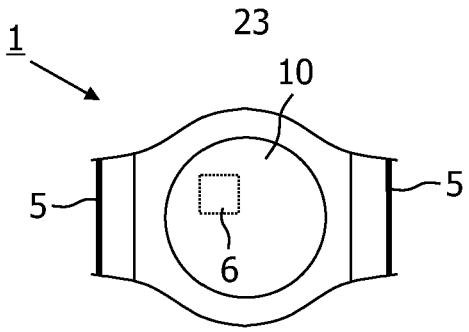


FIG. 1A

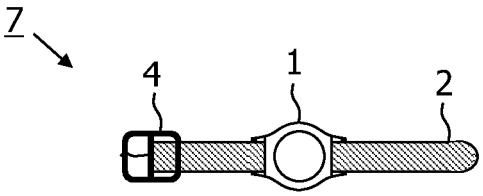


FIG. 1B

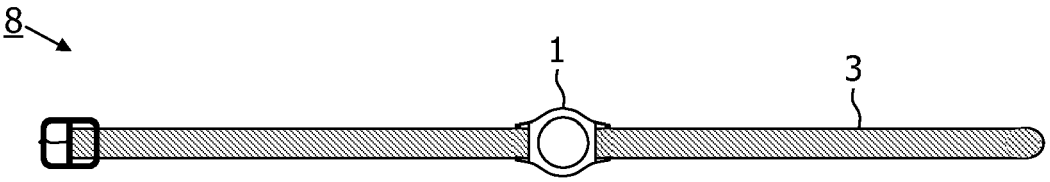


FIG. 1C

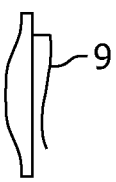


FIG. 1D

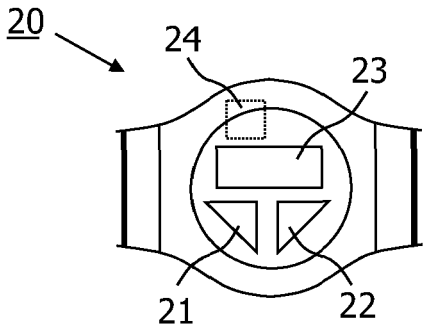


FIG. 2

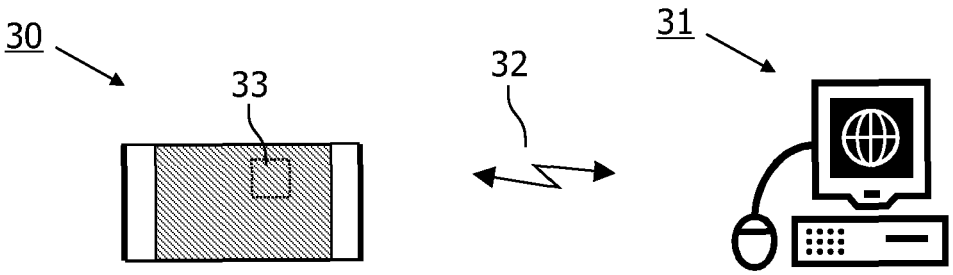


FIG. 3

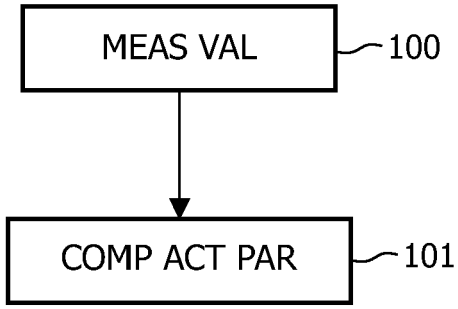


FIG. 4

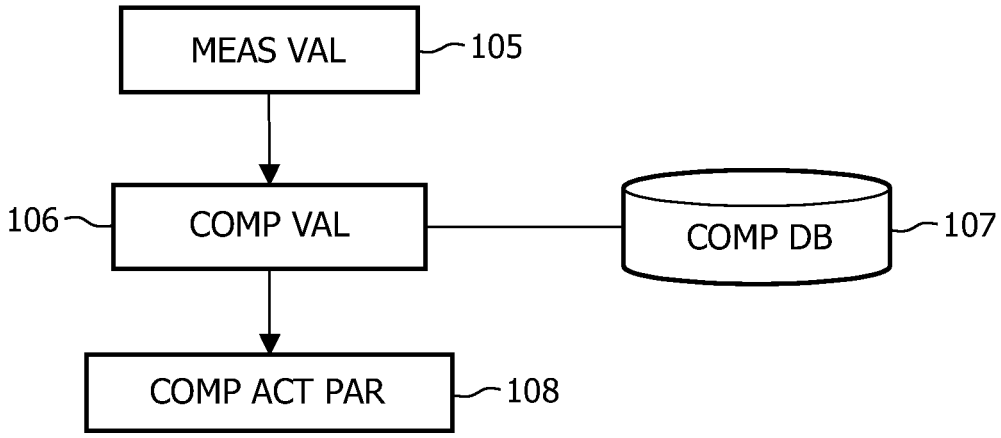


FIG. 5A

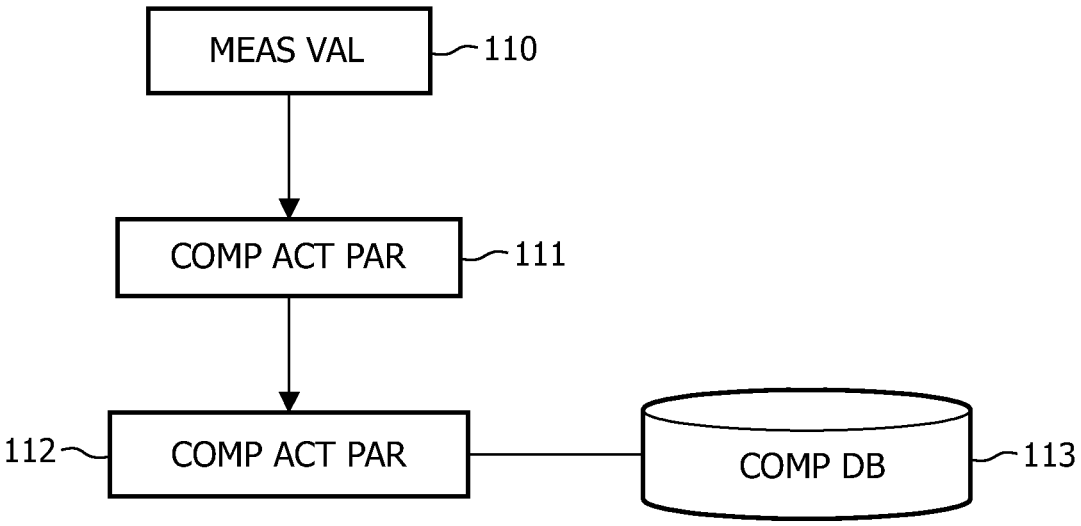


FIG. 5B

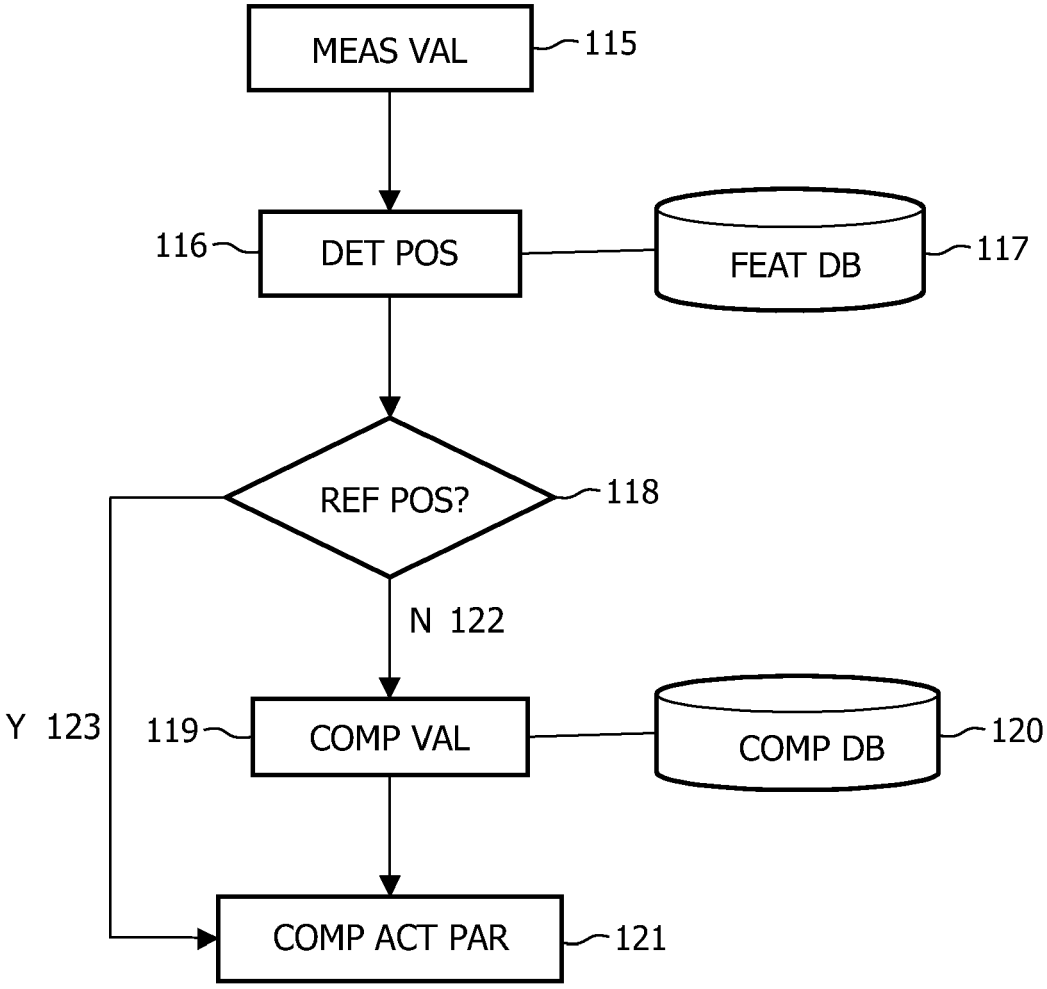

MEAS VAL
115
116
DET POS
FEAT DB
117
REF POS?
118
N 122
Y 123
119
COMP VAL
COMP DB
120
COMP ACT PAR
121

FIG. 6

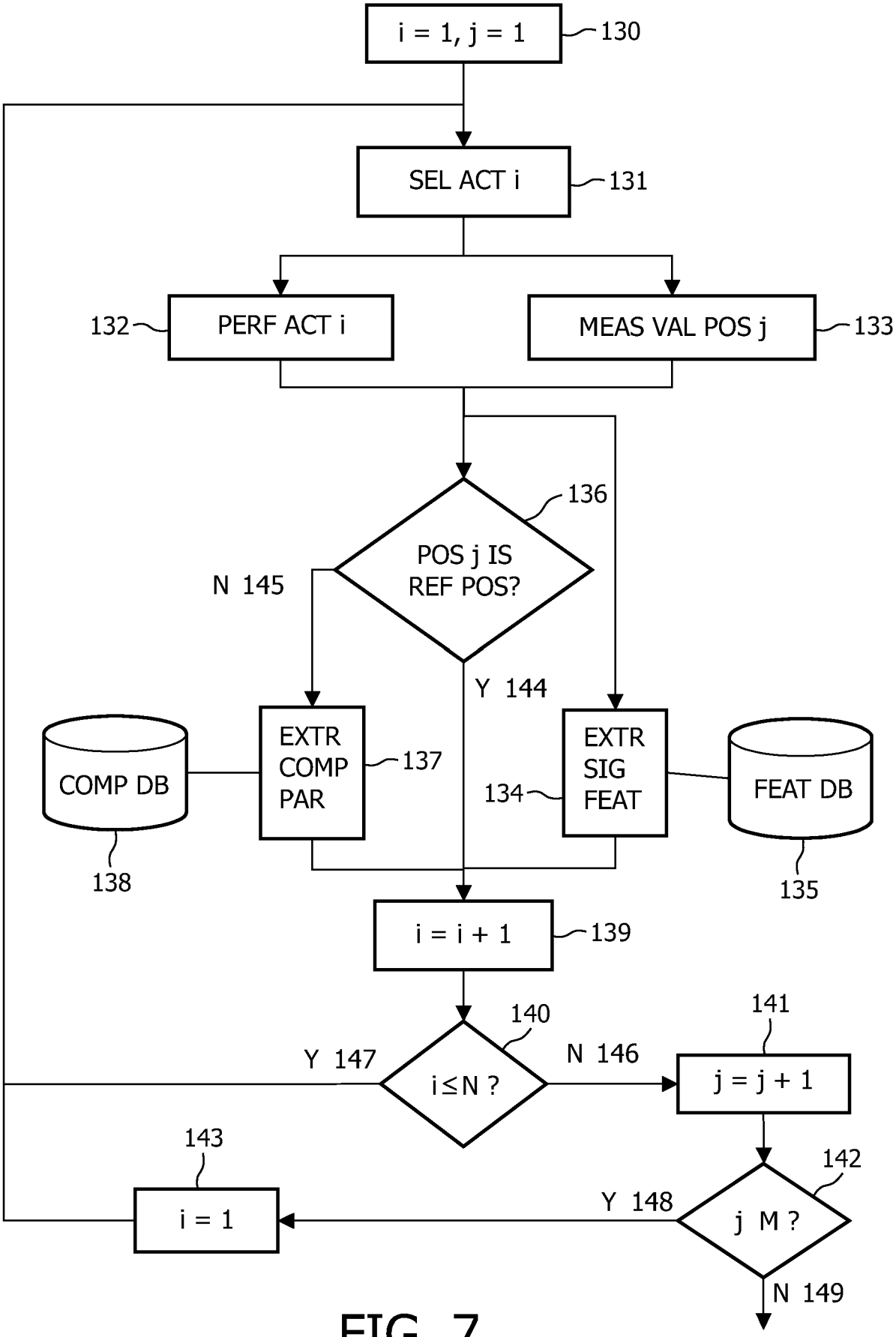

i = 1, j = 1
130
SEL ACT i
131
132
PERF ACT i
MEAS VAL POS j
133
136
POS j IS REF POS?
N 145
Y 144
EXTR COMP PAR
137
COMP DB
138
EXTR SIG FEAT
134
FEAT DB
135
i = i + 1
139
140
Y 147
i≤N ?
N 146
141
j = j + 1
142
Y 148
j M ?
N 149
143
i = 1

FIG. 7