(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 428 159 A3

(12) EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
25.07.2012 Bulletin 2012/30

(43) Date of publication A2:
14.03.2012 Bulletin 2012/11

(21) Application number: **11006415.1**

(22) Date of filing: **27.02.2004**

(51) Int Cl.:
A61B 5/024 *(2006.01)* ***A61B 5/1455*** *(2006.01)*
G01N 21/31 *(2006.01)* ***A61B 5/11*** *(2006.01)*
A61B 5/00 *(2006.01)* ***G06K 9/00*** *(2006.01)*
G06F 17/14 *(2006.01)*

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PT RO SE SI SK TR

(30) Priority: **27.02.2003 GB 0304413**
12.02.2004 GB 0403066
07.03.2003 GB 0305168

(62) Document number(s) of the earlier application(s) in accordance with Art. 76 EPC:
04715386.1 / 1 628 571

(71) Applicant: **Nellcor Puritan Bennett Ireland**
Mervue
Galway (IE)

(72) Inventors:
- **Addison, Paul Stanley**
  Edinburgh
  Midlothian EH10 6UR (GB)
- **Watson, James Nicholas**
  Dunfermline
  Fife KY11 8LE (GB)

(74) Representative: **Kinsler, Maureen Catherine**
Marks & Clerk LLP
Aurora
120 Bothwell Street
Glasgow
G2 7JS (GB)

(54) Analysing and processing photoplethysmographic signals by wavelet transform analysis

(57) A method of measuring physiological parameters, comprising: using a signal acquisition means to obtain a pulse oximetry signal; decomposing the pulse oximetry signal by wavelet transform analysis; identifying a primary band and a secondary band on a transform surface constructed by the wavelet transform analysis; and interpreting the secondary band to reveal information pertaining to the physiological parameters causing the primary band.

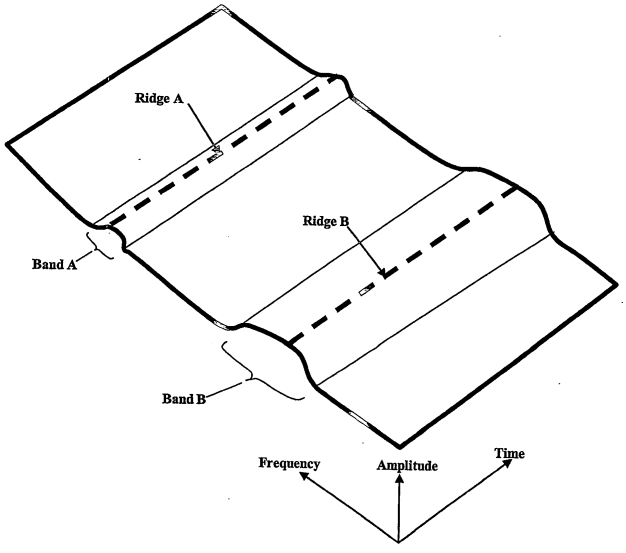

Figure 2

EP 2 428 159 A3

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 11 00 6415

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	US 6 094 592 A (YORKEY THOMAS J [US] ET AL) 25 July 2000 (2000-07-25) * column 3, line 19 - column 6, line 11; figures 1-4c * -----	1,9 2-8, 10-13	INV. A61B5/024 A61B5/1455 G01N21/31 A61B5/11
X	DOWLA F U ET AL: "NEURAL NETWORKS AND WAVELET ANALYSIS IN THE COMPUTER INTERPRETATION OF PULSE OXIMETRY DATA", NEURAL NETWORKS FOR SIGNAL PROCESSING. PROCEEDINGS OF THE IEEESIGNAL PROCESSING SOCIETY WORKSHOP, XX, XX, 1 January 1996 (1996-01-01), pages 527-536, XP001106543, * abstract * * page 531, paragraph 2 - page 533, paragraph 1 * -----	1,9	A61B5/00 G06K9/00 G06F17/14
X	WO 01/25802 A2 (NTC TECHNOLOGY INC [US]) 12 April 2001 (2001-04-12) * page 8, lines 19-30 * * page 10, line 7 - page 18, line 16 * * claim 30 * * figures 1-7 * -----	1,9	TECHNICAL FIELDS SEARCHED (IPC) A61B G01N G06F G06K
Y	US 6 122 535 A (KAESTLE SIEGFRIED [DE] ET AL) 19 September 2000 (2000-09-19) * column 4, line 31 - column 9, line 65; figures 1-6 * -----	2-5, 10-13	
Y	WO 03/000125 A (CARDIODIGITAL LTD ;WATSON JAMES NICHOLAS (GB); ADDISON PAUL STANLE) 3 January 2003 (2003-01-03) * page 3, line 14 - page 5, line 31 * * page 15, line 30 - page 26, line 12 * * figures 1-12 * -----	6-8, 10-13	
	-/--		

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
Munich	9 February 2012	Fischer, Olivier

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

1

EPO FORM 1503 03.82 (P04C01)

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 11 00 6415

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2002/103423 A1 (CHIN RODNEY [US] ET AL) 1 August 2002 (2002-08-01) * paragraphs [0008] - [0010], [0054] - [0059]; figures 1-2, 8A-11B *	1-13	
A	KIM J M ET AL: "Signal processing using fourier & wavelet transform for pulse oximery", TECHNICAL DIGEST / CLEO/PACIFIC RIM 2001, THE 4TH PACIFIC RIM CONFERENCE ON LASERS AND ELECTRO-OPTICS, IEEE SERVICE CENTER, PISCATAWAY, NJ, US, vol. 2, 15 July 2001 (2001-07-15), pages 310-311, XP010567311, ISBN: 978-0-7803-6738-8 * the whole document *	1-13	
A	RUSCH T L ET AL: "Signal processing methods for pulse oximetry", COMPUTERS IN BIOLOGY AND MEDICINE, NEW YORK, NY, US, vol. 26, no. 2, 1 March 1996 (1996-03-01), pages 143-159, XP004532247, ISSN: 0010-4825, DOI: 10.1016/0010-4825(95)00049-6 * the whole document *	1-13	TECHNICAL FIELDS SEARCHED (IPC)
A	LEONARD P ET AL: "Standard pulse oximeters can be used to monitor respiratory rate", JOURNAL OF ACCIDENT AND EMERGENCY MEDICINE, BMJ PUBLISHING GROUP, LONDON, GB, vol. 20, no. 6, 10 January 2003 (2003-01-10), pages 524-525, XP007901554, ISSN: 1351-0622 * the whole document *	1-13	

-/--

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
Munich	9 February 2012	Fischer, Olivier

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 11 00 6415

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X,P	PAUL S ADDISON ET AL: "RAPID COMMUNICATION; A novel time-frequency-based 3D Lissajous figure method and its application to the determination of oxygen saturation from the photoplethysmogram; Rapid Communication", MEASUREMENT SCIENCE AND TECHNOLOGY, IOP, BRISTOL, GB, vol. 15, no. 11, 1 November 2004 (2004-11-01), pages L15-L18, XP020066422, ISSN: 0957-0233, DOI: 10.1088/0957-0233/15/11/L01 * the whole document * -----	1-5,9-11	
X,P	ADDISON P S ET AL: "Oxygen saturation determined using a novel wavelet ratio surface", MEDICAL ENGINEERING & PHYSICS, BUTTERWORTH-HEINEMANN, GB, vol. 27, no. 3, 1 April 2005 (2005-04-01), pages 245-248, XP004735493, ISSN: 1350-4533, DOI: 10.1016/J.MEDENGPHY.2004.10.002 * the whole document * -----	1,6-11	TECHNICAL FIELDS SEARCHED (IPC)

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
Munich	9 February 2012	Fischer, Olivier

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

Europäisches Patentamt
European Patent Office
Office européen des brevets

Application Number
EP 11 00 6415

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-13

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

Europäisches Patentamt
European Patent Office
Office européen des brevets

LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 11 00 6415

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-13

   Claims 1-8 and 9-13 pertain to a method and system for measuring a physiological parameter, using pulse oximetry with red and IR light, decomposing each pulse oximetry signal by wavelet transform analysis and combining the decomposed signals to obtain a measure of (abnormal) oxygen saturation.

   ---

2. claims: 14-16

   Claims 14-16 pertain to a method and system for measuring movement artefact in a pulse oximetry signal using a wavelet transform analysis of the pulse oximetry signal, determining the modulus maxima of the transform surface and associating it with a movement artefact.

   ---

3. claims: 17-21

   Claims 17-19, 20-21 pertain to a method and system for measuring a physiological parameter using pulse oximetry and a wavelet transform analysis of the pulse oximetry signal, identifying a dominant band in the transform surface, the band corresponding to pulse components.

   ---

4. claims: 22-27

   Claims 22-27 pertain to a physiological measurement system with pulse oximetry means, wavelet transform means, feature extraction means, an analyser component and data output means, the feature extraction means comprising one or more of a respiration component, an oxygen saturation component, a movement measurement means and a pulse component, the system being worn by the patient.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 11 00 6415

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

09-02-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6094592 A	25-07-2000	AT 345730 T	15-12-2006
		AU 744836 B2	07-03-2002
		AU 3938899 A	13-12-1999
		CA 2342776 A1	02-12-1999
		DE 69934111 T2	28-06-2007
		EP 1079728 A1	07-03-2001
		ES 2278443 T3	01-08-2007
		JP 2002516130 A	04-06-2002
		US 6094592 A	25-07-2000
		WO 9960918 A1	02-12-1999
WO 0125802 A2	12-04-2001	AT 284061 T	15-12-2004
		DE 60016445 D1	05-01-2005
		DE 60016445 T2	08-12-2005
		EP 1224566 A2	24-07-2002
		US 6519486 B1	11-02-2003
		WO 0125802 A2	12-04-2001
US 6122535 A	19-09-2000	DE 69700253 D1	08-07-1999
		DE 69700253 T2	23-09-1999
		EP 0870466 A1	14-10-1998
		JP 4201876 B2	24-12-2008
		JP 10323342 A	08-12-1998
		US 6122535 A	19-09-2000
WO 03000125 A	03-01-2003	AT 424139 T	15-03-2009
		AT 520341 T	15-09-2011
		EP 1399056 A1	24-03-2004
		EP 2067437 A1	10-06-2009
		EP 2319397 A1	11-05-2011
		EP 2319400 A1	11-05-2011
		EP 2319401 A1	11-05-2011
		EP 2465419 A1	20-06-2012
		ES 2321282 T3	04-06-2009
		JP 4278048 B2	10-06-2009
		JP 2005500876 A	13-01-2005
		JP 2008212745 A	18-09-2008
		US 2005070774 A1	31-03-2005
		WO 03000125 A1	03-01-2003
US 2002103423 A1	01-08-2002	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

专利名称(译)	用小波变换分析分析和处理光电容积脉搏波信号		
公开(公告)号	EP2428159A3	公开(公告)日	2012-07-25
申请号	EP2011006415	申请日	2004-02-27
[标]申请(专利权)人(译)	NELLCOR PURITAN BENNETT爱尔兰		
申请(专利权)人(译)	NELLCOR PURITAN BENNETT爱尔兰		
当前申请(专利权)人(译)	NELLCOR PURITAN BENNETT爱尔兰		
[标]发明人	ADDISON PAUL STANLEY WATSON JAMES NICHOLAS		
发明人	ADDISON, PAUL STANLEY WATSON, JAMES NICHOLAS		
IPC分类号	A61B5/024 A61B5/1455 G01N21/31 A61B5/11 A61B5/00 G06K9/00 G06F17/14 A61B5/08		
CPC分类号	A61B5/726 A61B5/0002 A61B5/0082 A61B5/02416 A61B5/02438 A61B5/0816 A61B5/14551 A61B5/14552 A61B5/4818 A61B5/6826 A61B5/6829 A61B5/6838 A61B5/6896 A61B5/7207 A61B5/7214 A61B5/7278 A61B5/7282 A61B5/742 A61B2503/06 G01N21/3151		
审查员(译)	FISCHER，OLIVIER		
优先权	2003005168 2003-03-07 GB 2003004413 2003-02-27 GB 2004003066 2004-02-12 GB		
其他公开文献	EP2428159B1 EP2428159A2		
外部链接	Espacenet		

摘要(译)

一种测量生理参数的方法，包括：使用信号获取装置获得脉搏血氧测量信号;通过小波变换分析分解脉搏血氧饱和度信号;识别由小波变换分析构造的变换表面上的主带和次带;并解释次要频带以揭示与引起主要频带的生理参数有关的信息。

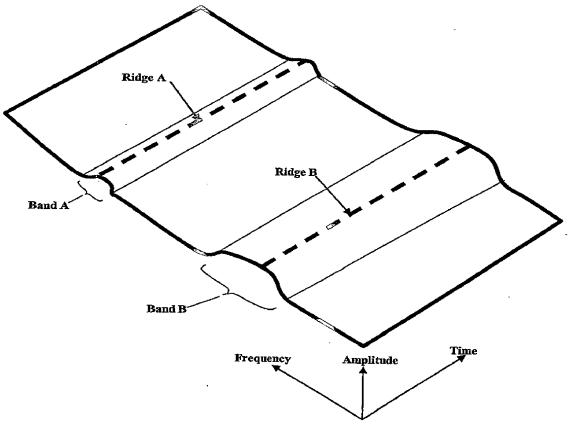

Figure 2