



- (51) International Patent Classification:  
*A61N 5/10* (2006.01)
- (21) International Application Number:  
PCT/IB2011/055143
- (22) International Filing Date:  
17 November 2011 (17.11.2011)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
10306277.4 19 November 2010 (19.11.2010) EP
- (71) Applicant (for all designated States except DE, US):  
**KONINKLIJKE PHILIPS ELECTRONICS N.V.**  
[NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).
- (71) Applicant (for DE only): **PHILIPS INTELLECTUAL PROPERTY & STANDARDS GMBH** [DE/DE];  
Lübeckertordamm 5, 20099 Hamburg (DE).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **GEORGI, Jens-Christoph** [DE/DE]; c/o Philips Research Laboratories,  
Weissshausstrasse 2, 52066 Aachen (DE). **EBLE, Michael**

**Johannes** [DE/DE]; c/o Philips Research Laboratories,  
Weissshausstrasse 2, 52066 Aachen (DE). **TORRES ESPALLARDO, Irene** [ES/DE]; c/o Philips Research Laboratories,  
Weissshausstrasse 2, 52066 Aachen (DE).

(74) Agents: **VAN VELZEN, Maaïke, M.** et al.; High Tech Campus, Building 44, NL-5600 AE Eindhoven (NL).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, 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, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, 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, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,

[Continued on next page]

(54) Title: METHOD AND APPARATUS FOR COMPENSATING INTRA-FRACTIONAL MOTION

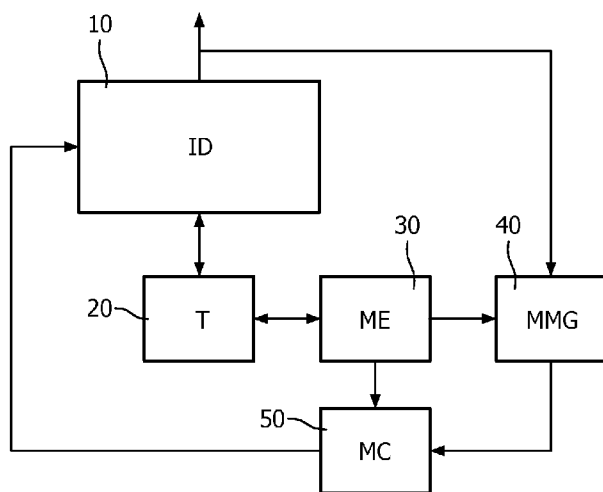


FIG. 1

(57) Abstract: The present invention proposes to couple easy to measure, robust external markers to a real internal tumor motion in a breathing model. By such a connection between internal motion and external markers, a reliable prediction of tumor position based on external markers alone is possible. Suitable models have already been developed and could be used and adapted right away. In a learning step the model is trained based on patient specific data containing both, the external marker characteristics and the internal motion, recorded synchronously. The internal motion can be determined by means of the motion estimation part of the local motion compensation algorithm.

WO 2012/066494 A3



SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,  
GW, ML, MR, NE, SN, TD, TG).

— *before the expiration of the time limit for amending the  
claims and to be republished in the event of receipt of  
amendments (Rule 48.2(h))*

**Published:**

— *with international search report (Art. 21(3))*

**(88) Date of publication of the international search report:**

12 July 2012

INTERNATIONAL SEARCH REPORT

International application No  
PCT/IB2011/055143

A. CLASSIFICATION OF SUBJECT MATTER  
INV. A61N5/10  
ADD. A61B5/087 A61B5/113

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)  
A61N

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 practicable, search terms used)  
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/212737 A1 (D SOUZA WARREN D [US] ET AL) 4 September 2008 (2008-09-04) paragraph [0011] paragraph [0016] paragraph [0017] paragraph [0032] paragraph [0033] paragraph [0040] paragraph [0042] paragraph [0044] paragraph [0048] paragraph [0051] paragraph [0052] paragraph [0054] paragraph [0086]  -----  -/--	1-11

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 application or patent 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  25 April 2012	Date of mailing of the international search report  08/05/2012
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  Rodríguez Cossío, J
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## INTERNATIONAL SEARCH REPORT

International application No  
PCT/IB2011/055143

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>WO 2010/083415 A1 (US HEALTH [US]; LI GUANG [US]; MILLER ROBERT W [US]; CAMPHAUSEN KEVIN)  22 July 2010 (2010-07-22)  page 2, line 22 - line 30  page 6, line 24 - line 30  page 14, line 10 - line 22  page 15, line 17 - page 16, line 3</p>	1-11
X	<p>US 2006/074292 A1 (THOMSON EUAN [US] ET AL) 6 April 2006 (2006-04-06)  paragraph [0048]  paragraph [0050]  paragraph [0132]  paragraph [0133]  paragraph [0134]  paragraph [0135]  paragraph [0142]  paragraph [0146]; claim 1</p>	1-11
X	<p>US 2009/175406 A1 (ZHANG HUI [US] ET AL) 9 July 2009 (2009-07-09)  paragraph [0005]  paragraph [0014]  paragraph [0016]  paragraph [0020]  paragraph [0021]  paragraph [0022]  paragraph [0024]  paragraph [0025]</p>	1-11
X	<p>US 2009/180666 A1 (SHENG YE [US] ET AL) 16 July 2009 (2009-07-16)  paragraph [0022]</p>	1-11
X	<p>US 2006/074299 A1 (SAYEH SOHAIL [US]) 6 April 2006 (2006-04-06)  paragraph [0038]  paragraph [0040]</p>	1-11
X	<p>PAUL KEALL: "4-Dimensional Computed Tomography Imaging and Treatment Planning", SEMINARS IN RADIATION ONCOLOGY, SAUNDERS, PHILADELPHIA, PA, US, vol. 14, no. 1, 1 January 2004 (2004-01-01), pages 81-90, XP002461023, ISSN: 1053-4296, DOI: 10.1053/J.SEMRADONC.2003.10.006  page 87</p>	1-11

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International application No  
PCT/IB2011/055143

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Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>ACHIM SCHWEIKARD ET AL: "Robotic motion compensation for respiratory movement during radiosurgery", COMPUTER AIDED SURGERY, vol. 5, no. 4, 1 January 2000 (2000-01-01) , pages 263-277, XP55025514, ISSN: 1092-9088, DOI: 10.1002/1097-0150(2000)5:4&lt;263::AID-IGS5&gt;3 .0.CO;2-2 page 263 - page 268</p> <p style="text-align: center;">-----</p>	1-11
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X	<p>VEDAM S S ET AL: "Quantifying the predictability of diaphragm motion during respiration with a noninvasive external marker", MEDICAL PHYSICS, AIP, MELVILLE, NY, US, vol. 30, no. 4, 1 April 2003 (2003-04-01), pages 505-513, XP012012027, ISSN: 0094-2405, DOI: 10.1118/1.1558675 the whole document</p> <p style="text-align: center;">-----</p>	1-11
A	<p>MURPHY MARTIN ET AL: "Optimization of an adaptive neural network to predict breathing", MEDICAL PHYSICS, AIP, MELVILLE, NY, US, vol. 36, no. 1, 5 December 2008 (2008-12-05), pages 40-47, XP012129695, ISSN: 0094-2405, DOI: 10.1118/1.3026608 the whole document</p> <p style="text-align: center;">-----</p>	6
A	<p>ISAKSSON MARCUS ET AL: "On using an adaptive neural network to predict lung tumor motion during respiration for radiotherapy applications", MEDICAL PHYSICS, AIP, MELVILLE, NY, US, vol. 32, no. 12, 29 November 2005 (2005-11-29), pages 3801-3809, XP012075244, ISSN: 0094-2405, DOI: 10.1118/1.2134958 the whole document</p> <p style="text-align: center;">-----</p> <p style="text-align: center;">-/--</p>	6

## INTERNATIONAL SEARCH REPORT

International application No  
PCT/IB2011/055143

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>TSUNASHIMA Y ET AL: "Correlation between the respiratory waveform measured using a respiratory sensor and 3D tumor motion in gated radiotherapy", INTERNATIONAL JOURNAL OF RADIATION: ONCOLOGY BIOLOGY PHYSICS, PERGAMON PRESS, USA, vol. 60, no. 3, 1 November 2004 (2004-11-01), pages 951-958, XP004600547, ISSN: 0360-3016, DOI: 10.1016/J.IJROBP.2004.06.026 the whole document</p>	1-11
A	<p>-----</p> <p>MINOHARA S ET AL: "RESPIRATORY GATED IRRADIATION SYSTEM FOR HEAVY-ION RADIOTHERAPY", INTERNATIONAL JOURNAL OF RADIATION: ONCOLOGY BIOLOGY PHYSICS, PERGAMON PRESS, USA, vol. 47, no. 4, 1 January 2000 (2000-01-01), pages 1097-1103, XP001051093, ISSN: 0360-3016, DOI: 10.1016/S0360-3016(00)00524-1 the whole document</p>	1-11
A	<p>-----</p> <p>CIHAT OZHASOGLU ET AL: "Issues in respiratory motion compensation during external-beam radiotherapy", INTERNATIONAL JOURNAL OF RADIATION ONCOLOGYBIOLOGYPHYSICS, vol. 52, no. 5, 1 April 2002 (2002-04-01), pages 1389-1399, XP55025569, ISSN: 0360-3016, DOI: 10.1016/S0360-3016(01)02789-4 the whole document</p> <p>-----</p>	1-11

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/IB2011/055143

## Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.: 12, 13  
because they relate to subject matter not required to be searched by this Authority, namely:  
Rule 39.1(iv) PCT - Method for treatment of the human or animal body by therapy
2.  Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

### Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2011/055143

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