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[Continued on next page]

(54) Title: SYSTEM AND METHOD FOR FLUORESCENCE TOMOGRAPHY

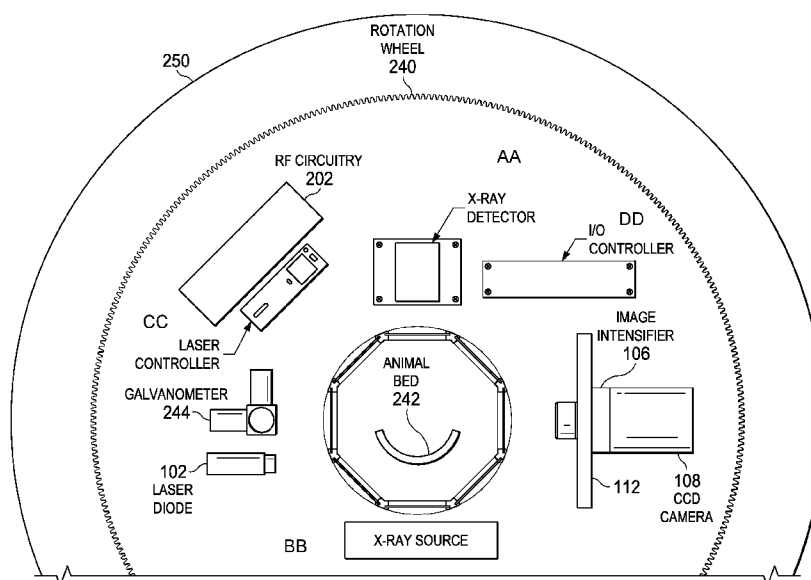


FIG. 2B

(57) Abstract: Systems and methods for near-infrared fluorescence (NIRF) imaging and frequency-domain photon migration (FDPM) measurements. An optical tomography system includes a bed, a wheel, a light source, an image detector, and radio frequency (RF) circuitry. The bed is configured to support an object to be imaged. The wheel is configured to rotate about the bed. The light source is coupled to the wheel. The image detector is coupled to the wheel and disposed to capture images of the object. The RF circuitry is coupled to the light source and the image detector. The RF circuitry is configured to simultaneously generate a modulation signal to modulate the light source, and generate a demodulation signal to modulate a gain of the image detector.

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

INTERNATIONAL SEARCH REPORT

PCT/US 14/30264

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G02B 26/08 (2014.01)

CPC - G01B 9/02

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)

IPC(8) - G02B 26/08 (2014.01)

CPC - G01B 9/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

IPC(8) - G02B 26/08 (2014.01)

CPC - G01B 9/02; USPC - 702/1; 359/368,372,385; 356/479,497 (text search - see terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatBase; PubWEST; Google

Search Terms Used: optical, tomography, wheel, bed, computerized, rotate, revolve, infrared, fluorescence, continuous wave, photon migration, light, room, platform, radio frequency, rf, demodulate, gain modulated, transform, boundary surface, transform

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y -- A	US 2007/0238957 A1 (YARED) 11 October 2007 (11.10.2007), entire document especially Figs 2, 14-15; paras [0094], [0098], [0102], [0113], [0180], [0181]	1-9, 17-20 ----- 10
Y -- A	CHOE, "Diffuse Optical Tomography And Spectroscopy Of Breast Cancer And Fetal Brain." A Dissertation, Presented to the Faculties of the University of Pennsylvania, December 2005 (12.2005), Abstract; pgs 3, 11, 47, 56-59, 129-131 [online] retrieved on 22 August 2014 (22.08.2014) Retrieved from the Internet: URL=<http://www.physics.upenn.edu/yodhlab/theses/regine_choe.pdf>	1-9, 17-20 ----- 10
Y -- A	US 2012/0310081 A1 (ADLER et al.) 06 December 2012 (06.12.2012), entire document especially para [0081]	1-9, 17-20 ----- 10
Y	US 2013/0023765 A1 (NALCIOGLU et al.) 24 January 2013 (24.01.2013), entire document especially para [0071]	9
A	US 2007/0258122 A1 (CHAMGOULOV et al.) 08 November 2007 (08.11.2007), entire document, especially; para [0002], [0003], [0025]-[0027]	1-10, 17-20
A	US 2005/0085732 A1 (SEVICK-MURACA et al.) 21 April 2005 (21.04.2005), entire document especially Fig 1; para [0012]	5

☐ Further documents are listed in the continuation of Box C.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search

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02 APR 2015

Name and mailing address of the ISA/US

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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.:
because they relate to subject matter not required to be searched by this Authority, namely:

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:
This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: claims 1-10, 17-20: drawn to an optical tomography system comprising a bed, a light source, and image detector, and RF circuitry coupled to the light source and image detector, configured to simultaneously generate a modulation signal to modulate the light source and generate a demodulation signal to modulate a gain of the image detector.

-- Please See Continuation Sheet --

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 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.:
1-10, 17-20

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.

Continuation of Box No. III -- Observations where unity of invention is lacking

Group II: claims 11-16: drawn to a method for performing FDPM and CW measurements in an optical tomograph system comprising a transformation matrix that allows determination of surface location of fluorescence measurement and excitation illumination locations using a calibration phantom to determine boundary surface location defined by a CT scanner; positioning an object in a path between a light source and an image detector; illuminating the object with a light source from a plurality of angles and capturing fluorescence data; irradiating the object with X-rays and capturing the X-rays to generate a CT scan of the boundary surface; applying the transformation matrix to align captured fluorescence data with surface locations that correspond to the surfaces acquired from the CT scan; and generating a composite image comprising the aligned fluorescence data and CT scan image.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

Special technical features:

Group I requires a bed, and RF circuitry coupled to the light source and image detector, configured to simultaneously generate a modulation signal to modulate the light source and generate a demodulation signal to modulate a gain of the image detector, not found in the other groups.

Group II requires a transformation matrix that allows determination of surface location of fluorescence measurement and excitation illumination locations using a calibration phantom to determine boundary surface location defined by a CT scanner, irradiating the object with X-rays and capturing the X-rays to generate a CT scan of the boundary surface; applying the transformation matrix to align captured fluorescence data with surface locations that correspond to the surfaces acquired from the CT scan; and generating a composite image comprising the aligned fluorescence data and CT scan image, not found in the other groups.

Shared Features:

The only technical features shared by Groups I and II that would otherwise unify the groups are an optical tomography system, having an object to be imaged, a light source configured to illuminate the object from different angles, and an image detector.

However, these shared technical features do not represent a contribution over prior art, because the shared technical features are disclosed by US 2007/0258122 A1 to Chamgoulov et al. (hereinafter 'Chamgoulov') 08 November 2007 (08.11.2007), which discloses an optical tomography system (para [0002], [0003], [0025]), having an object to be imaged (para [0026]), a light source configured to illuminate the object from different angles, and an image detector (para [0025]-[0027]).

As the shared technical features were known in the art at the time of the invention, they cannot be considered special technical features that would otherwise unify the groups.

Groups I-II therefore lack unity under PCT Rule 13 because they do not share a same or corresponding special technical feature.