



(51) International Patent Classification:
G01N 21/45 (2006.01)

(21) International Application Number:
PCT/US2014/040577

(22) International Filing Date:
2 June 2014 (02.06.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/830,006 31 May 2013 (31.05.2013) US

(71) Applicants: SUZHOU OPTORING TECHNOLOGY
CO. LTD. [CN/CN]; B202 Room, 1#building, 328 Xinghu
Avenue, Suzhou Industrial Park, Suzhou, 215123 (CN).
GENERAL PHOTONICS CORPORATION [US/US];
5228 Edison Avenue, Chino, CA 91710 (US).

(72) Inventors: WANG, Longzhi; B202 Room, 1# Building,
328 Xinghu Avenue, Suzhou Industrial Park, Suzhou,
215123 (US). MENG, Zhuo; B202 Room, 1# Building,

328 Xinghu Avenue, Suzhou Industrial Park, Suzhou,
215123 (CN). YU, Haimin; B202 Room, 1# Building, 328
Xinghu Avenue, Suzhou Industrial Park, Suzhou, 215123
(CN). YAO, Xiaotian, Steve; 23324 Ridge Line Road,
Diamond Bar, CA 91765 (US).

(74) Agent: AI, Bing; Perkins Coie LLP, P.O. Box 1247,
Seattle, WA 98111-1247 (US).

(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, BN, 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, IR, IS, JP, KE, KG, 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, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
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.

[Continued on next page]

(54) Title: RECONSTRUCTION OF OPTICAL COHERENT TOMOGRAPHY (OCT) IMAGES OF MORPHOLOGICAL FEATURES

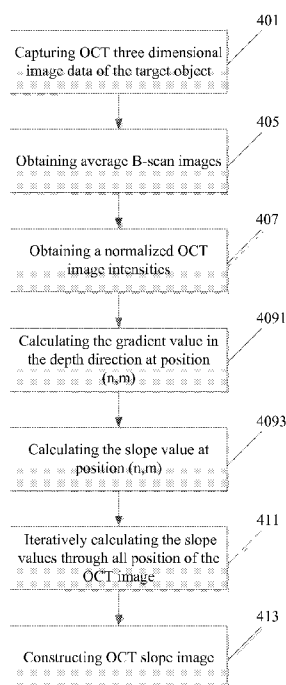


FIG. 4

(57) Abstract: Imaging devices and processing techniques based on imaging information along the depth direction in an optical coherent tomography (OCT) image are disclosed to enhance observed morphological features. The methods and systems obtain different OCT images of the target object under different reference path lengths, process the different OCT images to obtain a derivative with respect to the signal path length of image information of the different images, and processing the derivative to extract improved image information of the target object. The derivatives may be in a form related to a gradient value of the normalized OCT image intensity, or an attenuation coefficient.



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

Published:

- 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))

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

5 March 2015

Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))

INTERNATIONAL SEARCH REPORT

1147040577 09.01.2015

International application No.

PCT/US2014/040577

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G01N 21/45 (2014.01)

CPC - G01N 21/45 (2014.11)

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) -G01N 21/00, 17, 45 (2014.01)

USPC -356/450/477, 479; 702/189, 190, 191

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

CPC - G01N 21/00, 17, 45 (2014.11) (keyword document)

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

PatBase, Google Patents, Google Scholar, ProQuest.com

Search terms used: extracting, image, information, OCT, derivative, enhanced, attenuation

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2012/0213423 A1 (XU et al) 23 August 2012 (23.08.2012) entire document	1, 2
Y	US 2004/0109164 A1 (HORII et al) 10 June 2004 (10.06.2004) entire document	1, 2
A	US 2011/0015505 A1 (SCHURMAN et al) 20 January 2011 (20.01.2011) entire document	1-10
A	US 2011/0292400 A1 (FLEMING et al) 01 December 2011 (01.12.2011) entire document	1-10
A	US 2011/0201924 A1 (TEARNEY et al) 18 August 2011 (18.08.2011) entire document	1-10

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

* 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

22 December 2014

Date of mailing of the international search report

09 JAN 2015

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-3201

Authorized officer:

Blaine R. Copenheaver

PCT Helpdesk: 571-272-4300

PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

PCT/US2014/040577 05.01.2015

International application No.

PCT/US2014/040577

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:
see extra 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

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 III:

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, drawn to a method for extracting image information from images of a target object in an optical coherence tomography (OCT) device to reduce an effect of a signal decay due to scattering of light in the target object.

Group II, claims 11-15, drawn to a method for extracting image information from images of a target object in an OCT device to enhance image information of boundaries of heterogeneous layers in the target object.

Group III, claims 16-20, drawn to a method and device for processing OCT images to construct an OCT slope image of the target image.

Group IV, claims 21-23, drawn to an OCT device comprising an image processing device which reconstructs an OCT slope image having improved image information of the target object from the derivatives with respect to the signal path length through all positions of the denoised B-scan image.

Group V, claims 24-26, drawn to an OCT device comprising an image processing device which and reconstructs an enhanced OCT slope image having improved image information of the target object from the enhanced attenuation coefficients through all position of the averaged B-scan image.

The inventions listed as Groups I, II, III, IV and V 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: the special technical feature of the Group I invention: processing the derivative to extract improved image information of the target object to reduce an effect of a signal decay due to scattering of light in the target object as claimed therein is not present in the invention of Groups II, III, IV or V. The special technical feature of the Group II invention: processing the derivative to extract improved image information of the target object to enhance image information of boundaries of heterogeneous layers in the target object as claimed therein is not present in the invention of Groups I, III, IV or V. The special technical feature of the Group III invention: obtaining a gradient value of the normalized OCT image intensity with respect to the z coordinate; and using gradient values of the normalized OCT image intensities at different locations to construct an OCT slope image of the target image as claimed therein is not present in the invention of Groups I, II, IV or V. The special technical feature of the Group IV invention: calculates iteratively derivatives with respect to the signal path length through all positions of the denoised B-scan image; and reconstructs an OCT slope image having improved image information of the target object from the derivatives with respect to the signal path length through all positions of the denoised B-scan image as claimed therein is not present in the invention of Groups I, II, III or V. The special technical feature of the Group V invention: iteratively calculates enhanced attenuation coefficients through all position of the averaged B-scan image; and reconstructs an enhanced OCT slope image having improved image information of the target object from the enhanced attenuation coefficients through all position of the averaged B-scan image as claimed therein is not present in the invention of Groups I, II, III or IV.

Groups I, II, III, IV and V lack unity of invention because even though the inventions of these groups require the technical feature of an optical coherence tomography imaging device and method, and an image processing device and method, this technical feature is not a special technical feature as it does not make a contribution over the prior art in view of US 2012/0213423 A1 XU et al. 23 August 2012, as Xu teaches an optical coherence tomography imaging devices and method (boosting learning algorithm trained to automatically identify or segment features in a 3D OCT image, par. 8), and an image processing device and method (information processing apparatus execute the methods (e.g., in the form of an algorithm) described, par. 20).

Since none of the special technical features of the Group I, II, III, IV or V inventions are found in more than one of the inventions, unity of invention is lacking.