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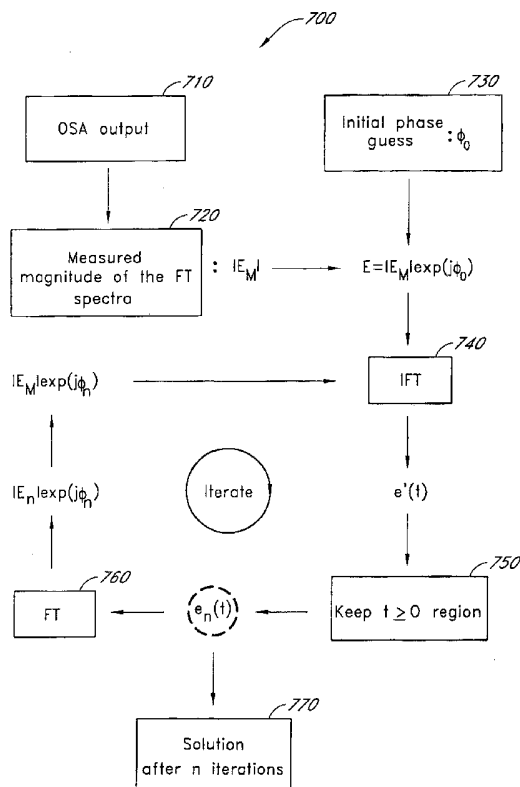
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| <p>(51) International Patent Classification:
 G02B 6/02 (2006.01) G01M 11/00 (2006.01)</p> <p>(21) International Application Number:
 PCT/US2005/017069</p> <p>(22) International Filing Date: 16 May 2005 (16.05.2005)</p> <p>(25) Filing Language: English</p> <p>(26) Publication Language: English</p> <p>(30) Priority Data:</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 33%;">60/571,660</td> <td style="width: 33%;">15 May 2004 (15.05.2004)</td> <td style="width: 33%;">US</td> </tr> <tr> <td>60/599,427</td> <td>6 August 2004 (06.08.2004)</td> <td>US</td> </tr> <tr> <td>60/662,684</td> <td>17 March 2005 (17.03.2005)</td> <td>US</td> </tr> </table> <p>(71) Applicant (for all designated States except US): THE BOARD OF TRUSTEES OF THE LELAND STANFORD JUNIOR UNIVERSITY [US/US]; 1705 El Camino Real, Palo Alto, California 94306-1106 (US).</p> <p>(72) Inventors: OZCAN, Aydogan; 565 Willow Road, Apt. #25', Menlo Park, California 94025 (US). DIGONNET,</p> | 60/571,660 | 15 May 2004 (15.05.2004) | US | 60/599,427 | 6 August 2004 (06.08.2004) | US | 60/662,684 | 17 March 2005 (17.03.2005) | US | <p>Michael, J.F.; 1045 College Avenue, Palo Alto, California 94306 (US). KINO, Gordon, S.; 867 Cedro Way, Stanford, California 94305 (US).</p> <p>(74) Agent: DELANEY, Karoline, A.; Knobbe, Martens, Olson & Bear, LLP, 2040 Main Street, 14th Floor, Irvine, California 92614 (US).</p> <p>(81) Designated States (<i>unless otherwise indicated, for every kind of national protection available</i>): 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, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.</p> <p>(84) Designated States (<i>unless otherwise indicated, for every kind of regional protection available</i>): 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,</p> |
| 60/571,660 | 15 May 2004 (15.05.2004) | US | | | | | | | | |
| 60/599,427 | 6 August 2004 (06.08.2004) | US | | | | | | | | |
| 60/662,684 | 17 March 2005 (17.03.2005) | US | | | | | | | | |

[Continued on next page]

- (54) Title:** METHOD OF CHARACTERIZING FIBER BRAGG GRATINGS USING ITERATIVE PROCESSING



(57) Abstract: A method determines a complex reflection impulse response of a fiber Bragg grating. The method includes providing a measured amplitude of a complex reflection spectrum of the fiber Bragg grating. The method further includes providing an estimated phase term of the complex reflection spectrum. The method further includes multiplying the measured amplitude and the estimated phase term to generate an estimated complex reflection spectrum. The method further includes calculating an inverse Fourier transform of the estimated complex reflection spectrum, wherein the inverse Fourier transform is a function of time. The method further includes calculating an estimated complex reflection impulse response by applying at least one constraint to the inverse Fourier transform of the estimated complex reflection spectrum.



FR, GB, GR, HU, IE, IS, IT, LT, LU, 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).

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.

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INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
G02B6/02 G01M11/00

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)
G02B G01M

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)

EP0-Internal, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	THOMAS F. QUATIERI, ALAN V. OPPENHEIM: "Iterative Techniques for Minimum Phase Signal Reconstruction from Phase or Magnitude" TRANSACTIONS ON ACOUSTICS, SPEECH, AND SIGNAL PROCESSING, vol. assp-29, no. 6, 1 December 1981 (1981-12-01), pages 1187-1193, XP002345561 cited in the application the whole document	1,2, 4-25, 27-39, 41-45
A	----- -/--	3,26,40

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in 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

16 January 2006

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02. 02. 2006

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2005/017069

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	I. POLADIAN: "Group-delay reconstruction for fiber Bragg gratings in reflection and transmission" OPTICS LETTERS, vol. 22, no. 20, 15 October 1997 (1997-10-15), pages 1571-1573, XP002345562 cited in the application the whole document	1,2, 4-25, 27-39, 41-45
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A	DING-WEI HUANG AND CHIH-CHUNG YANG: "Reconstruction of fiber grating refractive-index profiles from complex Bragg reflection spectra" APPLIED OPTICS, vol. 38, no. 21, 20 July 1999 (1999-07-20), pages 4494-4499, XP002362853 cited in the application page 4495, column 2, last paragraph - page 4496, column 1, paragraph 3; figure 1	46-53
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A	UWE WIEDMANN, PHILIPPE GALLION, AND GUNG-HUA DUAN: "A Generalized Approach to Optical Low-Coherence Reflectometry Including Spectral Filtering Effects" JOURNAL OF LIGHTWAVE TECHNOLOGY, vol. 16, no. 7, July 1998 (1998-07), pages 1343-1347, XP002362854 cited in the application the whole document	46-53
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A	SHAY KEREN AND MOSHE HOROWITZ: "Interrogation of fiber gratings by use of low-coherence spectral interferometry of noiselike pulses" OPTICS LETTERS, vol. 26, no. 6, 15 March 2001 (2001-03-15), pages 328-330, XP002362855 cited in the application the whole document	46-53
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A	DING-WEI HUANG AND C.C. YANG: "Retrieval of the refractive-index distribution of fiber gratings with complex Bragg reflection measurements" CONFERENCE ON LASERS AND ELECTRO-OPTICS 1999, BALTIMORE, USA, 23 May 1999 (1999-05-23), - 28 May 1999 (1999-05-28) page 297, XP002362856 the whole document	46-53
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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2005/017069

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1 339 254 A (AGILENT TECHNOLOGIES, INC) 27 August 2003 (2003-08-27) the whole document -----	46-53
A	US 5 062 703 A (WONG ET AL) 5 November 1991 (1991-11-05) column 7, line 49 - column 10, line 68; figure 4 -----	46-53

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2005/017069

Box 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 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 additional 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 an additional fee, this Authority did not invite payment of any additional fee.
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.

☒ No protest accompanied the payment of additional search fees.

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-45

Subject 1 relates to methods of calculating or determining the phase response of a fibre Bragg grating from the magnitude of the reflectance or transmittance, to means for storing these method steps in a readable form, and to computer systems with means for carrying out the methods.

2. claims: 46-53

Subject 2 relates to an apparatus for measuring the optical response of a fibre Bragg grating.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US2005/017069

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 1339254	A	27-08-2003	US 2003156275 A1	21-08-2003
US 5062703	A	05-11-1991	NONE	