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

(11) EP 1 524 626 A3

# (12) EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
**27.04.2005 Bulletin 2005/17**

(43) Date of publication A2:
**20.04.2005 Bulletin 2005/16**

(21) Application number: **04254228.2**

(22) Date of filing: **14.07.2004**

(51) Int Cl.[7]: **G06T 7/00**

(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 PL PT RO SE SI SK TR**
Designated Extension States:
**AL HR LT LV MK**

(30) Priority: **14.07.2003 US 487402**

(71) Applicant: **Sunnybrook & Women's College Health Sciences Centre**
**Toronto, Ontario M4N 3M5 (CA)**

(72) Inventors:
- **Tremblay, Marleine**
  **Toronto Ontario M6B 1B1 (CA)**
- **Tam, Fred**
  **Toronto Ontario M4K 2A2 (CA)**
- **Graham, Simon James**
  **Toronto Ontario M4G 2J5 (CA)**
- **Kucharczyk, John**
  **Bishop, GA 30621 (US)**

(74) Representative: **Bowman, Paul Alan**
**Lloyd Wise**
**Commonwealth House,**
**1-19 New Oxford Street**
**London WC1A 1LW (GB)**

## (54) Optical image-based position tracking for magnetic resonance imaging

(57) An optical image-based tracking system determines the position and orientation of objects such as biological materials or medical devices within or on the surface of a human body undergoing Magnetic Resonance Imaging (MRI). Three-dimensional coordinates of the object to be tracked are obtained initially using a plurality of MR-compatible cameras. A calibration procedure converts the motion information obtained with the optical tracking system coordinates into coordinates of an MR system. A motion information file is acquired for each MRI scan, and each file is then converted into coordinates of the MRI system using a registration transformation. Each converted motion information file can be used to realign, correct, or otherwise augment its corresponding single MR image or a time series of such MR images. In a preferred embodiment, the invention provides real-time computer control to track the position of an interventional treatment system, including surgical tools and tissue manipulators, devices for in vivo delivery of drugs, angioplasty devices, biopsy and sampling devices, devices for delivery of RF, thermal energy, microwaves, laser energy or ionizing radiation, and internal illumination and imaging devices, such as catheters, endoscopes, laparoscopes, and like instruments. In other embodiments, the invention is also useful for conventional clinical MRI events, functional MRI studies, and registration of image data acquired using multiple modalities.

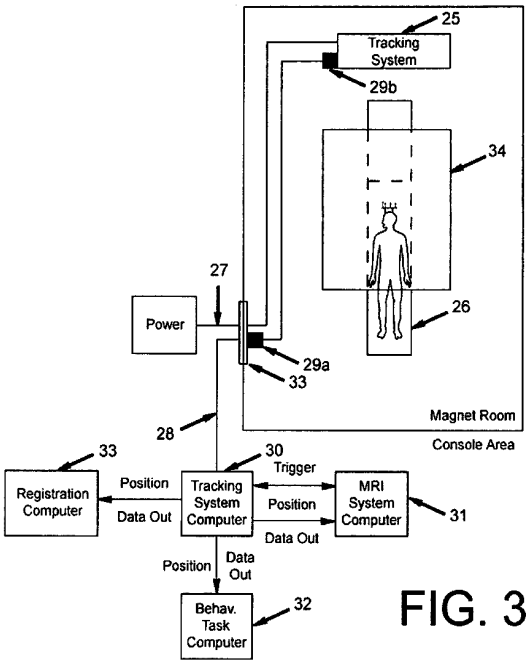


FIG. 3

EP 1 524 626 A3

European Patent Office

# PARTIAL EUROPEAN SEARCH REPORT

which under Rule 45 of the European Patent Convention shall be considered, for the purposes of subsequent proceedings, as the European search report

Application Number EP 04 25 4228

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.7) |
|---|---|---|---|
| Y | PENNEC X ET AL: "Tracking brain deformations in time sequences of 3D US images" PATTERN RECOGNITION LETTERS, NORTH-HOLLAND PUBL. AMSTERDAM, NL, vol. 24, no. 4-5, February 2003 (2003-02), pages 801-813, XP004391218 ISSN: 0167-8655 * page 802, left-hand column, last paragraph - right-hand column, paragraph 1 * * page 803, left-hand column, paragraph 2 * * page 804, right-hand column, paragraph 2 - page 808, right-hand column, paragraph 2 * * page 811, left-hand column, paragraph 2 - paragraph 3 * | 1-10,21, 22,33, 35-38,41 | G06T7/00 |
| Y | WO 02/47031 A (YEDA RESEARCH AND DEVELOPMENT CO. LTD; IRANI, MICHAL; CASPI, YARON) 13 June 2002 (2002-06-13) * page 26, line 19 - page 30, line 3 * | 1-10,21, 22,33, 35-38,41 | TECHNICAL FIELDS SEARCHED (Int.Cl.7) G06T |

-/--

## INCOMPLETE SEARCH

The Search Division considers that the present application, or one or more of its claims, does/do not comply with the EPC to such an extent that a meaningful search into the state of the art cannot be carried out, or can only be carried out partially, for these claims.

Claims searched completely :

Claims searched incompletely :

Claims not searched :

Reason for the limitation of the search:

see sheet C

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 22 February 2005 | Tibaux, M |

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 (P04C07)

European Patent Office

# PARTIAL EUROPEAN SEARCH REPORT

Application Number
EP 04 25 4228

| DOCUMENTS CONSIDERED TO BE RELEVANT | | | CLASSIFICATION OF THE APPLICATION (Int.Cl.7) |
|---|---|---|---|
| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | |
| A | ROCHE A ET AL: "RIGID REGISTRATION OF 3-D ULTRASOUND WITH MR IMAGES: A NEW APPROACH COMBINING INTENSITY AND GRADIENT INFORMATION"<br>IEEE TRANSACTIONS ON MEDICAL IMAGING, IEEE INC. NEW YORK, US,<br>vol. 20, no. 10, October 2001 (2001-10), pages 1038-1049, XP001107728<br>ISSN: 0278-0062<br>* page 1040, left-hand column, paragraph 1 - paragraph 4 *<br>----- | 1-10,21, 22,33, 35-38,41 | |
| A | US 5 784 431 A (KALEND ET AL)<br>21 July 1998 (1998-07-21)<br>* column 6, line 25 - column 7, line 8 *<br>* column 9, line 8 - line 21 *<br>----- | 1-10,21, 22,33, 35-38,41 | TECHNICAL FIELDS SEARCHED (Int.Cl.7) |
| A | CASCIA LA M ET AL: "HEAD TRACKING VIA ROBUST REGISTRATION IN TEXTURE MAP IMAGES"<br>PROCEEDINGS OF THE 1998 IEEE COMPUTER SOCIETY CONFERENCE ON COMPUTER VISION AND PATTERN RECOGNITION. CVPR '98. SANTA BARBARA, CA, JUNE 23 - 25, 1998, IEEE COMPUTER SOCIETY CONFERENCE ON COMPUTER VISION AND PATTERN RECOGNITION, LOS ALAMITOS, CA : IEEE,<br>vol. CONF. 17, 23 June 1998 (1998-06-23), pages 508-514, XP000871508<br>ISBN: 0-7803-5063-4<br>* page 511, left-hand column, line 4 - right-hand column, last line *<br>----- | 1,35-37, 41 | |

EPO FORM 1503 03.82 (P04C10) 3

European Patent Office

INCOMPLETE SEARCH
SHEET C

Application Number
EP 04 25 4228

The examiner telephoned to the representative because the applicant has paid excess claim fees for claims 15 and 27 with his letter of 4 october 2004, but claims 15 and 27 actually depend on claims 13 and 14, for which the claim fee has not been paid. The representative decided to drop claims 15 and 27.

---

European Patent Office

Application Number
EP 04 25 4228

## CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

[X] Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):

1-10, 21,22,33,35-38, 41

[ ] No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

## 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:

[ ] 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:

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 04 25 4228

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.

22-02-2005

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| WO 0247031 A | 13-06-2002 | AU 2102302 A | 18-06-2002 |
| | | CA 2436607 A1 | 13-06-2002 |
| | | EP 1356431 A2 | 29-10-2003 |
| | | WO 0247031 A2 | 13-06-2002 |
| | | JP 2004523027 T | 29-07-2004 |
| | | US 2004071367 A1 | 15-04-2004 |
| US 5784431 A | 21-07-1998 | AU 5002997 A | 22-05-1998 |
| | | CA 2270357 A1 | 07-05-1998 |
| | | CN 1235684 A | 17-11-1999 |
| | | EP 0934573 A1 | 11-08-1999 |
| | | JP 2001503176 T | 06-03-2001 |
| | | KR 2000052875 A | 25-08-2000 |
| | | WO 9819272 A1 | 07-05-1998 |

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) | 基于光学图像的磁共振成像位置跟踪 | | |
| 公开(公告)号 | EP1524626A3 | 公开(公告)日 | 2005-04-27 |
| 申请号 | EP2004254228 | 申请日 | 2004-07-14 |
| [标]申请(专利权)人(译) | 阳光溪流女子学院健康科学中心 | | |
| 申请(专利权)人(译) | 森尼布鲁克和女子大学健康科学中心 | | |
| 当前申请(专利权)人(译) | 森尼布鲁克和女子大学健康科学中心 | | |
| [标]发明人 | TREMBLAY MARLEINE<br>TAM FRED<br>GRAHAM SIMON JAMES<br>KUCHARCZYK JOHN | | |
| 发明人 | TREMBLAY, MARLEINE<br>TAM, FRED<br>GRAHAM, SIMON JAMES<br>KUCHARCZYK, JOHN | | |
| IPC分类号 | A61B5/055 A61B19/00 G06T7/00 | | |
| CPC分类号 | G01R33/283 A61B5/055 A61B5/7285 A61B34/20 A61B90/36 A61B90/361 A61B90/39 A61B2034/2055 A61B2034/2057 A61B2034/2065 A61B2034/2072 A61B2090/3937 A61B2090/3954 A61B2090/3983 | | |
| 代理机构(译) | 鲍曼PAUL ALAN | | |
| 优先权 | 60/487402 2003-07-14 US | | |
| 其他公开文献 | EP1524626A2 | | |
| 外部链接 | Espacenet | | |


摘要(译)

基于光学图像的跟踪系统确定经历磁共振成像（MRI）的人体表面内或表面上的诸如生物材料或医疗装置的物体的位置和取向。最初使用多个MR兼容相机获得要跟踪的对象的三维坐标。校准过程将利用光学跟踪系统坐标获得的运动信息转换为MR系统的坐标。针对每个MRI扫描获取运动信息文件，然后使用配准变换将每个文件转换为MRI系统的坐标。每个转换的运动信息文件可用于重新对齐，校正或以其他方式增加其相应的单个MR图像或这种MR图像的时间序列。在优选实施例中，本发明提供实时计算机控制以跟踪介入治疗系统的位置，包括手术工具和组织操纵器，用于体内递送药物的装置，血管成形术装置，活组织检查和取样装置，用于递送的装置。 RF，热能，微波，激光能量或电离辐射，以及内部照明和成像设备，例如导管，内窥镜，腹腔镜等仪器。在其他实施例中，本发明还可用于常规临床MRI事件，功能性MRI研究和使用多个获取的图像数据的配准方式。


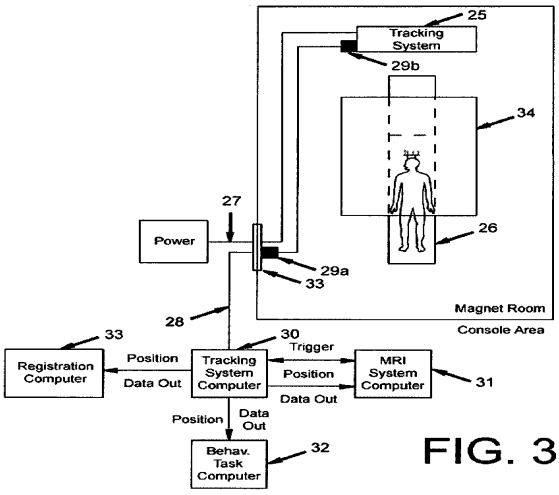


FIG. 3