(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
10 June 2010 (10.06.2010)

PCT

(10) International Publication Number
WO 2010/064155 A1

(51) International Patent Classification:
A61B 19/00 (2006.01) *A61B 5/06* (2006.01)
A61B 5/055 (2006.01)

(21) International Application Number:
PCT/IB2009/054924

(22) International Filing Date:
5 November 2009 (05.11.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/120,180 5 December 2008 (05.12.2008) US

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(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, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, 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, 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, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

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

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

[Continued on next page]

(54) **Title**: ACTIVE DEVICE TRACKING USING LIGHT WITH ORBITAL ANGULAR MOMENTUM TO INDUCE A HYPERPOLARIZED MRI

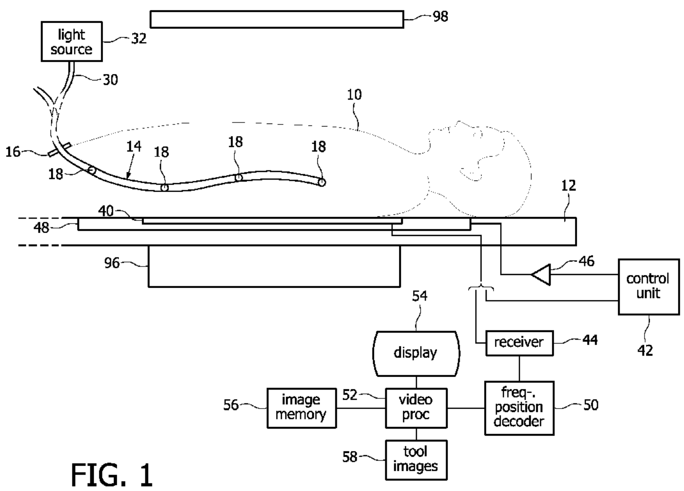


FIG. 1

(57) **Abstract**: One or more light beam endowed with photonic orbital angular momentum generating devices (18) are mounted at preselected locations on an insertable instrument (14) to hyperpolarize nuclear magnetic dipoles in a region of interest (80). The hyperpolarized nuclear magnetic dipoles are caused to resonate, generating magnetic resonance signals. A controller (42) controls gradient coils to induce a magnetic field gradient across the region of interest, such that the frequency of the resonance signals is indicative of spatial position. A frequency-to-position decoder (50) converts the resonance signal frequencies into spatial positions. A video processor (52) combines the spatial positions and a portion of a diagnostic image from a diagnostic image memory (56) into a combined display which depicts the location of the region of interest or a portion of the instrument marked on the diagnostic image and displays the combined image on a monitor (54).

WO 2010/064155 A1

Published:

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

ACTIVE DEVICE TRACKING USING LIGHT WITH ORBITAL ANGULAR MOMENTUM TO INDUCE A HYPERPOLARIZED MRI

The present application relates to the tracking arts. It finds particular application with image guided, minimally invasive surgical procedures and will be described with particular reference thereto. However, it will also find application in conjunction with the location of other instrumented objects.

When performing minimally invasive image guided surgery, the surgical region and the working end of the surgical instrument is typically not visible to the surgeon. Rather, the surgeon "sees" the surgical region via diagnostic images. In order for these minimally invasive surgical systems to function as intended, the surgeon needs to know where the working end of the surgical instrument is relative to the target tissue(s) in the surgical region area of the patient and the diagnostic image.

Mechanical tracking systems rigidly affix surgical tools to a static reference plane, such as the operating table. A series of instrumented joints between the static frame of reference plane and the tool allow the tool to be manipulated. This approach is appropriate only for rigid tools and often has a significantly restricted range of motion/ergonomics.

Some tracking techniques measure the working end or tip of the instrument indirectly. That is, when using a rigid tool, such as a biopsy needle, tracking elements are placed on the visible end of the instrument, e.g., light or other energy emitters or reflectors. Light from the emitters is tracked by video cameras or the like. By electronically calculating the position of the light emitters and by knowing the geometric relationship between the light emitters and the tip of the instrument, the location of the tip can be mathematically calculated. These indirect methods have drawbacks such as inaccuracy if the instrument is not rigid, if the surgeon or other equipment in the room blocks the line of sight between the light emitter and the electronic system, and the like.

Other techniques have been developed which locate the working end or tip of the instrument directly in three dimensions. For example, the tip of the instrument can be imaged with x-ray fluoroscopic or CT techniques. However, these radiation-based techniques subject the patient, and, to a lesser extent, the medical personnel in the room to a significant amount of radiation.

In another technique, the tip or other portions of the instrument are configured such that they show up in a magnetic resonance image. This enables additional diagnostic images to be generated periodically to monitor movement of the instrument. This technique tends to be relatively slow and requires the surgical site to be in the bore or imaging region of an MRI scanner.

In another technique, an active antenna is disposed adjacent the tip. This antenna is used to measure applied magnetic resonance imaging signals from which it generates coordinates of the antenna in three dimensions in the coordinate system of the MRI scanner. This requires wires from the antenna that run the length of the instrument to external circuitry, which are subject to heating under the fields applied during magnetic resonance imaging. Moreover, this technique suffers from inaccuracy in the vicinity of metal objects which distort the fields, and in the presence of the highly magnetic environment found inside an MRI scanner.

The present application contemplates a new and improved tracking technique which overcomes the above-referenced problems and others.

In accordance with one aspect, a tracking system for an insertable instrument is provided. At least one light beam endowed with orbital angular momentum generating device is configured to be mounted to a selected location on the insertable instrument to hyperpolarize nuclear magnetic dipoles in a region of interest adjacent thereto. An RF coil receives resonance signals from the nuclear magnetic dipoles in the region of interest. A controller controls gradient coils for inducing a magnetic field gradient across the region of interest to encode spatial position in a frequency of the resonance signals. A radio frequency receiver receives the resonance signals from the RF coil and a frequency-to-position decoder converts the received nuclear magnetic resonance signals into corresponding spatial positions. An image memory stores a diagnostic image of a subject into which the insertable instrument is to be inserted. Optionally, a video processor combines the spatial position from the frequency-to-position decoder and at least a portion of the diagnostic image from the diagnostic image memory into a combined display with the location of the region of interest or a portion of the instrument marked on the diagnostic image and controls the display of the combined image on a monitor.

In accordance with another aspect, a method of tracking an insertable instrument is provided. With the instrument inserted into a subject, nuclear magnetic dipoles are polarized in a region of interest at a preselected location along the instrument using light beams endowed with orbital angular momentum. A magnetic resonance sequence is applied which identifies locations of the polarized nuclear magnetic dipoles.

In one embodiment, the OAM hyperpolarized nuclear spins are polarized in at any orientation relative to a $B_{0,}$ which represents a constant uniform magnetic field such as the one produced by the bore of an MRI instrument; this approach enables standard MR-localization pulse sequences, using non-selective or thick slab excitations, to be used to detect the polarized nuclear spins and localize the device. Detection of the device is possible because the hyperpolarized nuclear spins resonance response have an increased signal intensity relative to the background signal which contains nuclear spins that are weakly polarized by the MR system's B_0 magnetic field.

One advantage resides in improved accuracy in tracking the working end or tip of surgical instruments.

Another advantage resides in the generation of tip location information substantially in real time during a surgical procedure.

Another advantage resides in freedom from or at least minimal interference with movement of the surgeon and other instruments around the patient during surgery.

Still further advantages and benefits will become apparent to those of ordinary skill in the art upon reading and understanding the following detailed description.

The invention may take form in various components and arrangements of components, and in various steps and arrangements of steps. The drawings are only for purposes of illustrating the preferred embodiments and are not to be construed as limiting the invention.

FIGURE 1 is a diagrammatic illustration of a patient, an insertable instrument, and tracking system;

FIGURE 2 is a diagrammatic illustration of an exemplary working end of an instrument instrumented with a light beam endowed with orbital angular momentum tracking system;

FIGURE 3 is an alternate embodiment of an instrument with a light beam endowed with orbital angular momentum tracking system;

FIGURE 4 illustrates details of an exemplary light beam endowed with orbital angular momentum generating system for generating hyperpolarized nuclear magnetic dipoles.

With reference to FIGURE 1, a patient **10** is disposed on a support surface **12** in preparation for a minimally invasive surgical procedure. A minimally invasive surgical device such as a catheter **14** is inserted into the patient through a port **16**, e.g., in the femoral artery. A light beam endowed with orbital angular momentum generation device **18** is disposed at one or more known locations along the catheter, e.g., adjacent the tip. By way of example, a balloon catheter is typically inserted through the port **16** and fed along the patient's arterial system to the location of the blockage, when inserting a stent or performing balloon angioplasty. As the catheter moves through the arterial system, it is tracked to mark its location. Guide wires or other navigational systems are used to direct the tip of the catheter to follow the appropriate branches to use the arterial system analogous to a highway system to bring the tip to the location of the blockage.

With continuing reference to FIGURE 1 and further reference to FIGURE 2, the catheter **14** is a balloon catheter connected with a balloon **20** (illustrated inflated), connected with an air channel **22**, for selectively inflating it. A guide wire passage **24** receives a guide wire **26** for causing the tip of the catheter to turn in a selected direction. A channel **28** terminates in a port for releasing imaging contrast agents, medications, and the like into the blood adjacent the tip of the catheter.

The light beam endowed with orbital angular momentum generator **18** is connected to an optic fiber **30** which extends through the catheter. The optic fiber **30** extends from a light source **32** external to the patient to the light beam endowed with orbital angular momentum generating device **18**. The light beam endowed with orbital angular momentum generating device **18** uses light endowed with orbital angular momentum to hyperpolarize nuclear magnetic dipoles, such as protons or hydrogen magnetic dipoles in blood or other body tissues adjacent the tip. The hyperpolarization occurs in a very limited location, but is 1,000-1,000,000 times greater than the polarization achieved with today's commercial magnetic resonance imaging systems. The polarized nuclear magnetic dipoles can be caused to resonate at a frequency that is proportional to the strength of a surrounding magnetic field. Using magnetic field gradients analogous to an MRI imaging system, the frequency with which these dipoles resonate can be positionally encoded.

With continuing reference to FIGURE 1, an RF coil **40** is disposed adjacent the patient. In the embodiment of FIGURE 1, the RF coil is embedded into the patient support **12** adjacent its upper surface. However, the RF coil can be positioned in other locations, such as on the surface of the patient, above the patient, or the like. A control unit **42** controls either the RF coil **40** or the light beam endowed with orbital angular momentum generating device to induce nuclear magnetic resonance in the hyperpolarized nuclear magnetic dipoles. The resonating dipoles generate a magnetic resonance signal of a characteristic frequency which is received and demodulated by a receiver **44**.

The controller **42** further controls a gradient magnetic field generating system in which a gradient coil power supply **46** supplies pulses of power to gradient coils **48**. In the illustrated embodiment, the gradient coils **48** include x, y, and z-gradient coils for inducing magnetic field gradients in each of three orthogonal directions. Planar gradient coils may be of the construction commonly used in open MRI systems. The resonance frequency of the resonance signal varies in accordance with the strength of the magnetic field. Thus, when the gradient magnetic field is applied, the frequency of the received resonance signal is indicative of its spatial position. For example, the controller causes the gradient power supply **46** to cause the x-gradient coil to apply an x-gradient and the receiver receives the magnetic resonance signal. From the frequency of the x-gradient signal, a frequency to position decoder **50** determines the position of the light beam endowed with orbital angular momentum generating device **18** in the spatial coordinate system of the gradient coils, hence the patient support **12**. This process is repeated to obtain the spatial position in the y- and z-directions. Although a linear gradient magnetic field simplifies the frequency to spatial position calculation, other gradient shapes can also be used.

Video processor **52** controls a display device **54** to display a diagnostic image of the patient from an image memory **56**. The diagnostic image is aligned with the coordinate system of the patient support and the patient using any of a variety of known techniques. Typically, the diagnostic image is a three-dimensional image and the surgeon displays one or more selected slices. The selected slices typically change such that at least one displayed slice includes the plane in which the orbital angular momentum generation device **18** lies. Because the diagnostic image is spatially aligned or coordinated with the patient support **12**, the x-, y-, and z-positional information from the frequency to position decoder **50** is used by the video processor **52** to identify the voxel of the diagnostic image corresponding to the position of the orbital angular momentum generating device, the tip of the instrument, or other point on the instrument that is positioned with a known offset from the angular momentum generating device. In one embodiment, the position of the focal point of the light beam endowed with orbital angular momentum generating device is displayed as a bright spot, cross hairs, or other symbol on one or more of the displayed diagnostic images. Alternately, a diagnostic tool image generator **58** generates an image representation of the catheter or other inserted device or a portion thereof for superimposition on the diagnostic image.

With reference to FIGURE 3, one or more light beam endowed with angular momentum generators **18** are disposed along the insertable instrument. Each light beam endowed with orbital angular momentum generator is again connected with a light source via an optical fiber **30**. Each light beam endowed with orbital angular momentum generator **18** generates light beam endowed with orbital angular momentum which it uses to hyperpolarize the magnetic dipoles of the nuclei in one or more samples **60**. In one example, the samples are small, hollow beads which contain a hyperpolarizable substance. In one embodiment, the hyperpolarizable substance is a noble gas like xenon or helium. In another embodiment, the hyperpolarizable material is a liquid, such as water or an oil. By positioning two samples along an axis of the inserted instrument, the trajectory of the instrument can be determined. By positioning a third sample which is non-collinear with the first two, a rotational orientation of the insertable device can be determined. By positioning hyperpolarized samples along the length of the device, the path which the inserted instrument is following can be illustrated in the displayed diagnostic image. An end effector **62** is controlled via a control line or channel **62**, e.g., a pneumatic system.

With reference to FIGURE 4, the light beam endowed with orbital angular momentum generating device **18** includes an arrangement of optical elements, preferably disposed on a small chip or microchip sized to be accommodated in the inserted instrument. In the balloon catheter example, balloon catheters (with the balloon not inflated) are commonly about 2-5 mm in diameter. Further, although the electromagnetic radiation which is to be endowed with orbital angular momentum is described as visible mono-chromatic or multi-chromatic (e.g. white) light, other types of electromagnetic radiation are also contemplated. Visible light interacts with hydrogen atoms and other atoms or molecules of interest and has no damaging effect on living tissue. More specifically, visible light indirectly creates a magnetic dipole polarization in the protons via its interactions with the electron orbitals and the angular momentum of the molecule. There are other frequencies of electromagnetic radiation which enable the protons to be interacted with directly. Electromagnetic radiation or light above or below the visible spectrum is also contemplated. Modifying the frequency content of the light and/or the amount of orbital angular momentum in the light beam enables some molecules to be more strongly polarized and enables specific molecules to be selectively polarized. The beam of light carried by the optical fiber or other waveguide **30** is expanded by a beam expander **78**. The beam expander includes an entrance collimator **72** for collimating the light or electromagnetic radiation into a narrow beam. A concave lens **74** diverges the light beam which is refocused by a focusing lens **76**. The intensity non uniformity of the light beam is rejected with an exit collimator **78**. In one embodiment, the exit collimator narrows the beam to about 1 mm.

A linear polarizer **80** and quarter wave plate **82** circularly polarize the light. The linear polarizer gives the unpolarized light a single linear polarization and the quarter wave plate shifts the linearly polarized light by a quarter wavelength, circularly polarizing it. Using circularly polarized light is not essential, but has the added advantage of polarizing the spin states of electrons.

The circularly polarized light is passed through a phase pattern or phase hologram **84** which imparts orbital angular momentum to the light beam. The order ***l*** of the orbital angular momentum is dependent on the phase hologram **84**. In one embodiment, a value of ***l***=40 is imparted to incident light, although higher values of ***l*** are also contemplated. Alternately, the phase pattern or hologram **84** may be embodied in other optics, such as combinations of cylindrical lenses, wave plates, fixed phase holograms in glass or plastic, or the like.

Not all the light passing through the holographic plate **84** is imparted with orbital angular momentum. Generally, when electromagnetic waves interact with the phase hologram, they are diffracted into a diffraction pattern. The middle represents the 0^{th} order diffraction which, in this case, is light with no orbital angular momentum. Patterns adjacent to this center component represent diffracted beams of different orders that are composed of photons beams carrying orbital angular momentum.

A spatial filter **86** is placed after the holographic plate to selectively pass only light with the desired orbital angular momentum through an aperture and blocks all other diffracted components of light. That is, the spatial filter **86** passes light having orbital angular momentum of only one value. The light passed by the spatial filter **86** is collected using concave mirror(s) **88** and focused on the region of interest **90** with a convergent lens **92**. The light endowed with orbital angular momentum is advantageously focused on the region of interest within a image size as close as possible to the size of the Airy disk associated to the light carrying the same Gaussian beam frequency. Again, the region of interest can either be tissue adjacent the inserted instrument or a liquid or gas sample that is incorporated into the device **60**.

Rather than using only the light with orbital angular momentum to polarize the nuclear magnetic dipoles of interest, the light can be used to supplement a magnetic field. The magnetic field can be the B_0 magnetic field of a magnetic resonance imaging system, or a magnetic field supplied by the tracking system. In one example, a permanent magnet **94** is positioned adjacent the target dipoles and appropriately oriented to generate a steady state magnetic field through the region of interest in which nuclear magnetic resonance is to be induced. In another embodiment, a magnet **96** is disposed below the patient support **12** to generate a vertical B_0 field through the region of interest. Optionally, a pole piece of opposite polarity or a flux focusing structure **98** can be disposed above the subject, e.g., on the ceiling of the operating room, or the like. In another alternate embodiment, the gradient and radio frequency coils are the gradient and radio frequency coils of an open or other magnetic resonance imaging system.

The invention has been described with reference to the preferred embodiments. Modifications and alterations may occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

In interpreting the appended claims, it should be understood that:

a) the word "comprising" does not exclude the presence of other elements or acts than those listed in a given claim;

b) the word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements;

c) any reference numerals in the claims are for illustration purposes only and do not limit their protective scope; and

d) several "means" may be represented by the same item or hardware or software implemented structure or function.

CLAIMS

1. A tracking system for an insertable instrument (14) comprising:

at least one photonic orbital angular momentum generating device (18) configured to be mounted to a selected location on the insertable instrument (14) to hyperpolarize dipoles in a region of interest (90) adjacent thereto;

an RF coil (40) which receives nuclear magnetic resonance signals from the nuclear magnetic dipoles in the region of interest;

a controller (42) which controls gradient coils (48) for inducing a magnetic field gradient across the region of interest, the gradient magnetic field encoding spatial position in a frequency of the resonance signals;

a radio frequency receiver (44) which receives the nuclear magnetic resonance signal from the RF coil (40);

a frequency-to- position decoder (50) which converts the received nuclear magnetic resonance signals into corresponding spatial positions;

an image memory (56) which stores a diagnostic image of a subject into which the insertable instrument is to be inserted; and, optionally,

a video processor (52) which combines the spatial position from the frequency-to-position decoder (50) and at least a portion of the diagnostic image from the diagnostic image memory (56) into a combined display with the location of the region of interest or a portion of the instrument marked on the diagnostic image and controls the display of the combined image on a monitor (54).

2. The tracking system according to claim 1, further including a sample (60) disposed in the region of interest (90) such that the photonic orbital angular momentum generating device polarizes nuclear spins and nuclear magnetic dipoles in the sample using the interaction of the light endowed with orbital angular momentum with molecular angular momentum, molecular orbitals, electron spin states and nuclei spin states.

3. The tracking system according to claim 1, further including a waveguide (30), such as an optic fiber, for conveying electromagnetic radiation, such as

light, from external to the subject through the insertable instrument to a light beam endowed with the photonic orbital angular momentum generating device (18).

4. The tracking system according to claim 1, further including:

a patient support (12) on which the patient is supported, the diagnostic image being spatially aligned with the patient support; and

wherein, at least one of the RF coil (40) and the gradient coils (48) are embedded in the patient support so as not to interfere with a surgeon during a surgical procedure.

5. The tracking system according to claim 1, further including:

a magnet (94, 96) positioned to generate a static magnetic field through the region of interest.

6. The tracking system according to claim 1, further including:

a permanent magnet (94) configured to be mounted in the insertable instrument adjacent the region of interest (90).

7. The tracking system according to claim 1, further including:

a sample (60), such as a gas, a liquid, a solid or native biological tissue, in the region of interest (90), the photonic orbital angular momentum device hyperpolarizing nuclear spins in the sample.

8. The tracking system according to claim 1, further including:

a plurality of regions of interest (90) in which nuclear spins resonate, each of the regions of interest being at a preselected position relative to the instrument (14), the video processor (52) generating a depiction of at least a portion of the instrument based on the plurality of resonating regions of interest for display superimposed on the displayed diagnostic image.

9. A method of tracking an insertable instrument (14), the method comprising:

with the instrument (14) inserted into a subject (10), polarizing nuclear magnetic dipoles in a region of interest (80) at a preselected location along the instrument by imparting orbital angular momentum to spins of the dipoles;

applying a magnetic resonance sequence which identifies locations of the polarized nuclear magnetic dipoles.

10. The method according to claim 9, wherein the step of polarizing the nuclear magnetic dipoles includes hyperpolarizing the nuclear spins in any orientation relative to the static magnetic field (B_0); and

the magnetic resonance sequence applying step includes applying RF and gradient field pulses to detect the polarized nuclear magnetic dipoles and localize the instrument.

11. The method according to claim 9, further including:

superimposing a representation of the spatial position of the region of interest or a selected portion of the instrument onto a diagnostic image of the subject and displaying the diagnostic image with the spatial position of the region of interest superimposed.

12. The method according to claim 9, wherein the step of polarizing nuclear magnetic dipoles in the region of interest includes:

conveying light from a light source (32) exterior to the subject through the insertable instrument (14) to an light beam endowed with orbital angular momentum generating device (18);

with the light beam endowed with orbital angular momentum generating device, converting the received light into light having orbital angular momentum of a single value;

directing the light endowed with orbital angular momentum on the region of interest to polarize dipoles therein.

13. The method according to claim 12, wherein the step of directing includes focusing the light endowed with orbital angular momentum on the region of interest within an image size taking into account the size of the Airy disk associated to the light carrying the same Gaussian beam frequency as the light endowed with orbital angular momentum.

14. The method according to claim 12, wherein the hyperpolarized nuclear magnetic dipoles are in a plurality of samples fixedly mounted to one or more light beam endowed with orbital angular momentum generation devices, the samples being disposed at each of a plurality of preselected locations along the insertable instrument, the method further including:

determining the spatial position of each of a plurality of samples; and

displaying the spatial location of each of the samples or a depiction of a portion of the instrument (14) derived from the plurality of sample locations superimposed on a diagnostic image of the subject.

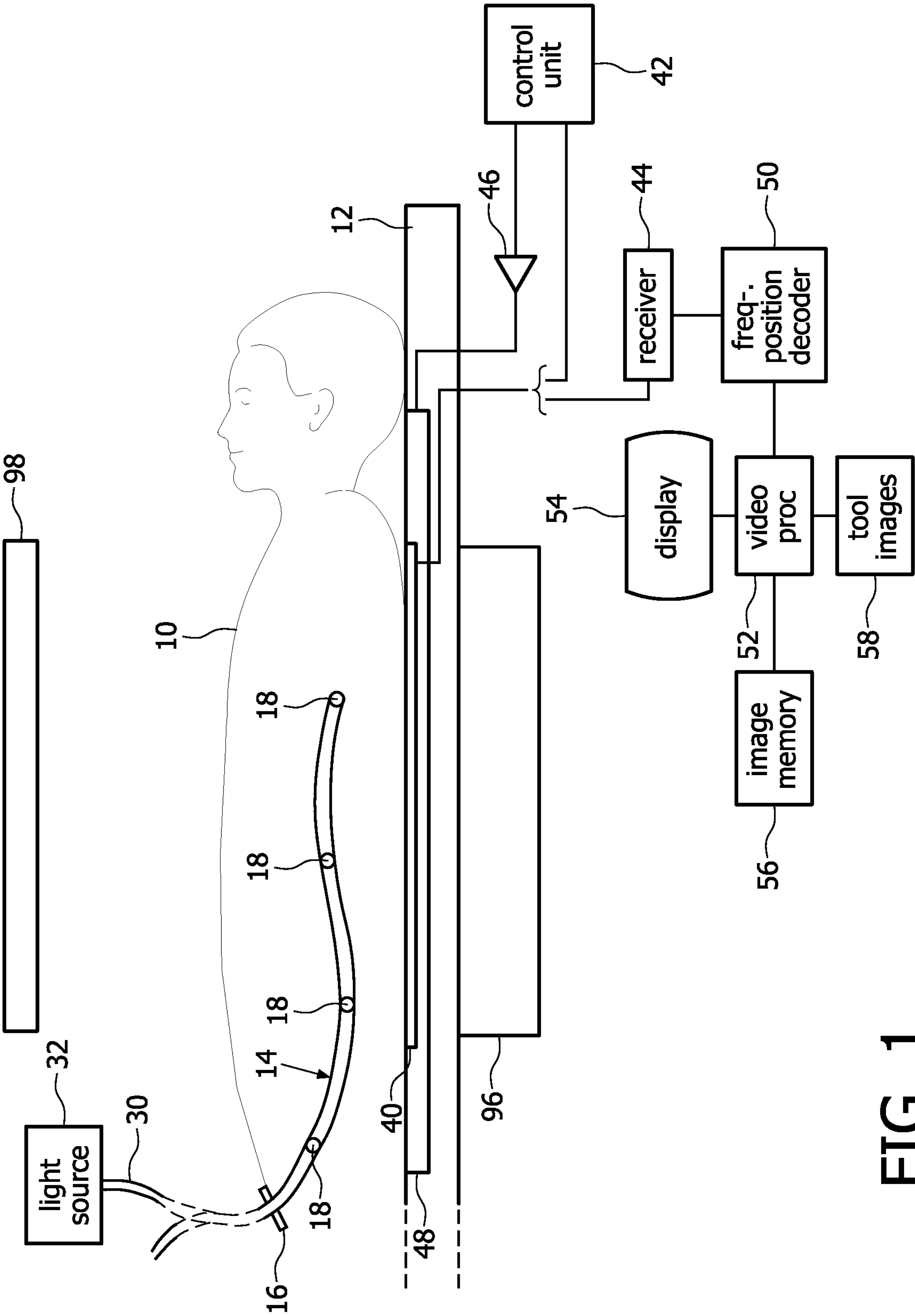
15. The method according to claim 9, further including:

moving the insertable instrument (14) through the subject (10); and

repeatedly determining the spatial position of the region of interest (80) to track the region of interest as the insertable instrument moves through the subject.

16. The method according to claim 15, wherein the insertable instrument (14) is a non-rigid instrument and further including:

steering a working end of the insertable instrument in accordance with the diagnostic image such that the region of interest and the working end of the insertable instrument follows a selected trajectory through the subject.


control unit
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video proc
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tool images
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light source
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96

FIG. 1

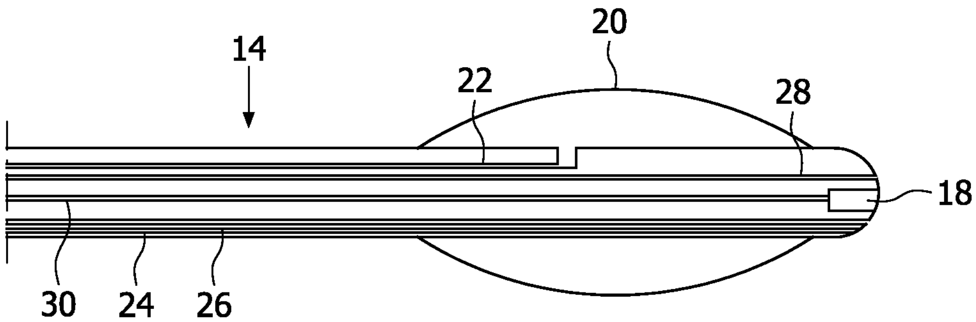

FIG. 2

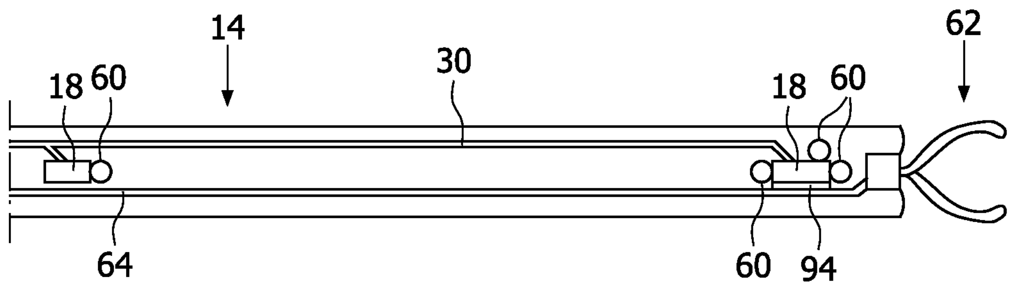

FIG. 3

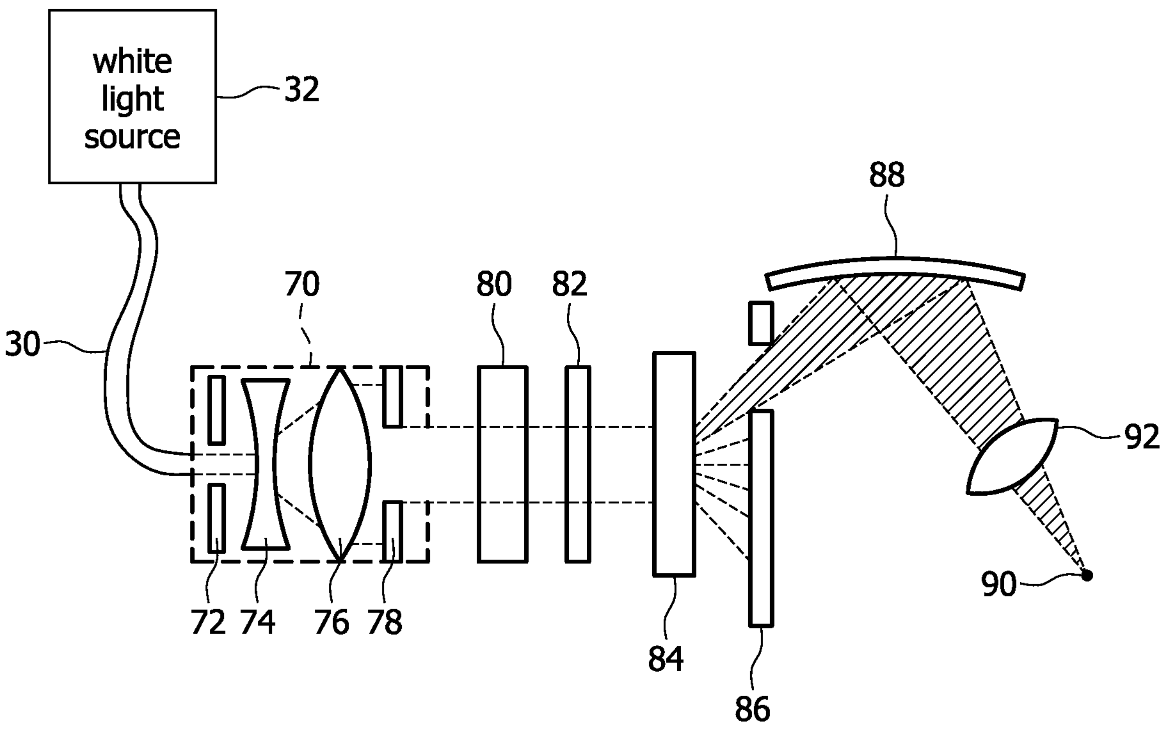

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/054924

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B19/00
ADD. A61B5/055 A61B5/06

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)
A61B

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)

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,P L	WO 2009/081360 A1 (KONINKL PHILIPS ELECTRONICS NV [NL]; ELGORT DANIEL R [US]; ALBU LUCIAN) 2 July 2009 (2009-07-02) page 8, line 13 - page 11, line 8 figures 2,6,7 -----	1-8
A	ELGORT D R ET AL: "Direct Optical Hyperpolarization of Liquids" PROCEEDINGS OF THE INTERNATIONAL SOCIETY FOR MAGNETIC RESONANCE IN MEDICINE, 16TH SCIENTIFIC MEETING AND EXHIBITION, TORONTO, ONTARIO, CANADA, 3-9 MAY 2008, INTERNATIONAL SOCIETY FOR MAGNETIC RESONANCE IN MEDICINE, US, 3 May 2008 (2008-05-03), page 3200, XP007908368 the whole document ----- -/--	1-8

[X] Further documents are listed in the continuation of Box C.

[X] 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

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Date of the actual completion of the international search	Date of mailing of the international search report
22 January 2010	03/02/2010

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Maier, Christian

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/054924

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	ALLEN L ET AL: "THE ORBITAL ANGULAR MOMENTUM OF LIGHT" PROGRESS IN OPTICS, XX, XX, vol. 39, 1 January 1999 (1999-01-01), pages 291-372, XP009115478 the whole document -----	1-8
A	BUCKINGHAM A D ET AL: "The effect of circularly polarized light on NMR spectra" MOLECULAR PHYSICS, TAYLOR & FRANCIS, GB, vol. 91, 1 August 1997 (1997-08-01), pages 805-814, XP009115500 ISSN: 0026-8976 the whole document -----	1-8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2009/054924

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. [X] Claims Nos.: 9-16
because they relate to subject matter not required to be searched by this Authority, namely:

Pursuant to Article 17(2)(a)(i) PCT, this Authority is not required to search the subject-matter of claims 9-16, since a method of tracking an insertable instrument as defined in claim 9 represents a method for treatment of the human or animal body by surgery (Rule 43bis PCT).

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/IB2009/054924

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2009081360 A1	02-07-2009	NONE	