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(54) MOTION DETECTION IN MEDICAL SYSTEMS

BEWEGUNGSERKENNUNG IN MEDIZINISCHEN SYSTEMEN

DÉTECTION DE MOUVEMENT DANS DES SYSTÈMES MÉDICAUX

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(56) References cited:
US-A1- 2004 152 975
US-A1- 2007 164 224
US-B1- 7 209 579

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Description

[0001] The following relates to the medical imaging, radiation therapy, and related arts. In some embodiments it relates to gamma camera systems, and is described with illustrative reference thereto. However, the following will find application in substantially any type of medical imaging system such as gamma cameras, positron emission tomography (PET) systems, magnetic resonance (MR) systems, or so forth in order to provide dynamic information regarding subject position or motion. The following will further find application in substantially any type of medical therapy system, such as radiation therapy systems, in which accurate dynamic knowledge of subject position or motion is advantageous.

[0002] It is advantageous for a patient to remain stationary during certain medical procedures, such as medical imaging, radiation therapy, and so forth. In practice, however, the patient may move, and in some cases must move, during the procedure. For example, the patient must breath during any procedure that takes more than a minute or so to perform. For longer procedures, there is a likelihood that the patient may shift his or her position at some point during the procedure due to fatigue, nervousness, or so forth. The likelihood of patient movement generally increases with increased duration of the procedure, and is also enhanced in the case of children and frail adults. Patient motion can be reduced, but not eliminated, through the use of patient restraints. However, most patients do not like to be placed into such restraints.

[0003] Recognizing a possibility of patient movement, one remedial approach is to compensate for the patient movement. Doing so entails determining patient position during the medical procedure. Some known approaches indirectly determine patient position, for example by using pressure transducers disposed on or in a belt around the patient to detect respiration. These indirect approaches generally entail some sort of modeling or other data transformation in order to extract a patient position estimate.

[0004] Another approach is to use cameras to monitor the patient during the procedure. For example, R.D. Beach et al., "Feasibility of stereo-infrared tracking to monitor patient motion during cardiac SPECT imaging", IEEE Trans. Nucl. Sci. vol. 51, pp. 2693-2698 (2004) discloses a method employing a plurality of cameras that monitor the patient. Reflective markers are disposed on the patient, and images acquired by the cameras are analyzed by stereoscopic image processing techniques to determine the positions of the reflective markers. This approach has the advantage of being a more direct measurement of patient position, and the reflecting spheres can be made small and compact and are generally not discomforting to the patient.

[0005] However, using cameras to monitor the patient is not feasible if the patient, or the portion of the patient which is of interest, is occluded from view. A gamma camera, for example, is typically operated with its detector heads located conformally as close as practicable to the patient during imaging, thus substantially occluding from view the portion of the patient that is of interest. Similarly, the imaged portion of a patient disposed in the bore of a magnetic resonance (MR) scanner or positron emission tomography (PET) scanner is substantially occluded from view by the scanner. The stereoscopic camera system also occupies a substantial amount of valuable space, and in interventional procedures medical personnel must take care not to block the cameras' view of the patient.

[0006] US7209759 discloses a medical imaging system including a cylindrical bore surrounding an examination region, a two-dimensional array of gamma detectors arranged to view the examination region, surrounding the examination region and means for determining the position or a marker disposed within the examination region.

[0007] The following provides improvements, which overcome the above-referenced problems and others.

[0008] The invention is defined in claims 1 and 12.

[0009] In some embodiments disclosed herein as illustrative examples, a position measurement system is disclosed, comprising: a two-dimensional array of photosensors configured to be disposed on a medically operative member being able to interact with or acquire data from a subject disposed in an examination region, the array of photosensors arranged to view the examination region, wherein the medically operative member comprises a) at least one radiation detector having a radiation-sensitive face configured to detect radiation of interest, the array of photosensors being generally planar and arranged parallel with the radiation-sensitive face, or b) a medical imaging system including a generally cylindrical bore surrounding the examination region, the array of photosensors being disposed on an inner surface of the generally cylindrical bore so as to view the examination region; and a position-determining member configured to determine a position of an optically detectable marker disposed with the subject in the examination region based on light from the optically detectable marker sensed by the array of photosensors.

[0010] In some embodiments disclosed herein as illustrative examples, a medical imaging arrangement is disclosed, comprising: at least one medically operative member being able to interact with or acquire data from a subject disposed in an examination region; a two-dimensional array of photosensors disposed on the at least one medically operative member, the array of photosensors arranged to view the examination region, wherein the at least one medically operative member comprises a) at least one radiation detector having a radiation-sensitive face configured to detect radiation of interest, the array of photosensors being generally planar and arranged parallel with the radiation-sensitive face, or b) a medical imaging system including a generally cylindrical bore surrounding the examination region, the array of photosensors being disposed on an inner surface of the generally cylindrical bore so as to view the examination region; and a position-determining member configured to determine a position of at least one optically detectable marker disposed with the subject in the examination region based on light from the at least one optically detectable marker sensed by the array of photosensors.

[0011] In some embodiments disclosed herein as illustrative examples, a position measurement method is disclosed, comprising: detecting at least one optically detectable marker disposed on a subject in an examination region using a two-dimensional array of photosensors disposed on a medically operative member being able to interact with or acquire data from the subject in the examination region, wherein the medically operative member comprises a) at least one radiation detector having a radiation-sensitive face configured to detect radiation of interest, the array of photosensors being generally planar and arranged parallel with the radiation-sensitive face, or b) a medical imaging system including a generally cylindrical bore surrounding the examination region, the array of photosensors being disposed on an inner surface of the generally cylindrical bore so as to view the examination region; and determining at least one optical marker position corresponding to the at least one optically detectable marker based on the detecting.

[0012] One advantage resides in providing a position-determining system for determining patient position during a medical procedure.

[0013] Another advantage resides in providing a position-determining system for determining patient position during a medical procedure in which a medically operative member substantially occludes from view at least a relevant portion of the patient.

[0014] Another advantage resides in providing a position-determining system for determining patient motion during a medical procedure.

[0015] Still further advantages of the present invention will be appreciated to those of ordinary skill in the art upon reading and understand the following detailed description.

[0016] The drawings are only for purposes of illustrating the preferred embodiments, and are not to be construed as limiting the invention.

FIGURE 1 diagrammatically shows a perspective view of a gamma camera system including a subsystem for determining patient position and movement.

FIGURE 2 diagrammatically shows a sectional view of one of the detector heads of the gamma camera system of FIGURE 1.

FIGURE 3 diagrammatically shows a sectional view of the gamma camera system of FIGURE 1 in which the position-determining sub-system includes photosensors with wide viewing angle, and the position-determining member includes Anger-type logic electronics.

FIGURE 4 diagrammatically shows a sectional view of the gamma camera system of FIGURE 1 in which the position-determining sub-system includes photosensors with narrow viewing angle so as to define optical projection data, and the position-determining member including back-projection electronics.

FIGURE 5 diagrammatically shows a sectional view of the gamma camera system of FIGURE 1 in which the position-determining sub-system includes photosensors disposed behind the detector head collimator so as to define optical projection data, and the position-determining member including back-projection electronics.

FIGURE 6 diagrammatically shows a sectional view of a magnetic resonance scanning system including a sub-system for determining patient position and movement.

[0017] With reference to FIGURE 1, an illustrated gamma camera system includes two radiation detector heads **10**, **12**. In other embodiments, the gamma camera may include one, two, three, four, five, six, seven, or more detector heads. The radiation detector heads **10**, **12** have respective radiation-sensitive faces **14**, **16**, which are generally arranged during operation to face a patient support or pallet **18**. The illustrated detector heads **10**, **12** are supported by respective articulated, multi-jointed robotic arms **20**, **22** that each include a combination of electronically controllable translational, rotational, swivel, or other mechanical joints that cooperatively or collectively enable several degrees of movement freedom, such as radial movement of the detector heads **10**, **12** toward or away from the patient couch **18**, tangential movement of the heads in a direction transverse to the radial movement, circumferential movement, or so forth. Camera electronics **24** power and control the articulated robotic arms **20**, **22** and the detector heads **10**, **12**, and acquire radiation detection information from the detector heads **10**, **12**. The camera electronics **24** are optionally coupled with a video monitor **26** for displaying information about the status and operation of the gamma camera. The camera electronics **24** include a robotic controller **28** that is operable by a hand controller **30** in a manual mode to manipulate the detector heads **10**, **12** using the robotic arms **20**, **22**, and is operable by suitable control algorithms implemented by the controller **28** to move one or both detector heads **10**, **12** along predetermined paths or trajectories. For example, in cardiac imaging the two detector heads **10**, **12** are typically positioned 90° apart around the subject support **18**. In some embodiments, the illustrated gamma camera including the radiation detectors **10**, **12**, patient support **18**, robotic arms **20**, **22**, camera electronics **24**, and video display **26** is suitably embodied by the Skylight™ nuclear camera (available from Philips Medical Systems, Eindhoven, The Netherlands), although other gamma cameras can be used.

[0018] With continuing reference to FIGURE 1 and with further reference to FIGURE 2, each detector head **10**, **12** includes a collimator **42** mounted on the radiation-sensitive face **14**, **16**. The collimator **42** is in some embodiments a pinhole, honeycomb, or other type of collimator made of radiation absorbing material and having pinholes, openings, or filled radiation transmissive regions that collimate incoming radiation in a direction generally transverse to the generally planar radiation-sensitive face **14**, **16**. In some embodiments, the collimator may be omitted, for example if the detector head is being used for positron emission tomography (PET) imaging. The illustrated detector heads **10**, **12** each further include an array of radiation detectors **44**. The illustrated radiation detectors **44** include one or more scintillators **46** optically coupled with a plurality of photomultiplier tubes **48** arranged to view the one or more scintillators **46**. The photomultiplier tubes **48** are optionally replaced by another type of light sensor, such as an array of photodiodes. The term "light" as used herein encompasses visible light and also invisible ultraviolet or infrared light. The outputs of the photomultiplier tubes **48** are input to electronics, for example disposed on a printed circuit board **50**. Instead of the scintillator-based radiation detectors **44**, a plurality of radiation sensitive elements, such as, for example, solid state cadmium-zinc-telluride (CZT) based detectors, can be used to directly absorb radiation and output an electrical signal responsive thereto.

[0019] To acquire tomographic imaging data, the robotic controller **28** manipulates the detector heads **10**, **12** using the robotic arms **20**, **22** to move the detector heads **10**, **12** around a subject disposed on the patient support or pallet **18**. In planar imaging, the detector heads **10**, **12** are not moved around the subject, but may optionally be moved linearly to scan a desired field of view. The detector heads **10**, **12** collect tomographic, planar, or other imaging data that are stored in an imaging data memory **60**. For example, the imaging data may be projection data in the case of SPECT imaging, or line-of-response data if the gamma camera is being used in a PET imaging mode, or so forth. A reconstruction member **62** applies a suitable reconstruction algorithm, such as a filtered backprojection reconstruction algorithm, an iterative reconstruction algorithm, or so forth, to compute a reconstructed image from the collected imaging data. The reconstruction member **62** is typically embodied as electronics such as a processor or controller executing a reconstruction algorithm; however, the reconstruction member **62** may be otherwise embodied, for example as an analog, digital, or mixed application-specific integrated circuit (ASIC) electronics operating alone or in conjunction with a controller or processor. The reconstructed image is stored in an image memory **64**, and may be displayed on the display of a user interface **66**, or stored for later retrieval in an electronic, magnetic, or optical memory, or transmitted via a local area network or the Internet, or processed by post-reconstruction image processing, or otherwise utilized. In the illustrated embodiment, the user interface **66** also provides user interfacing with the camera electronics **24**. In other embodiments, the video monitor **26**, hand controller **30**, or another user interfacing device may be used instead of or in addition to the user interface **66** to provide user interfacing with the camera electronics **24**.

[0020] The gamma camera described with reference to FIGURES 1 and 2 is an illustrative example. More generally, the position sensing apparatuses and methods disclosed herein can be practiced with substantially any type of gamma camera. For example, it can be used in conjunction with gamma cameras having a larger number of smaller detector heads. In some embodiments, the robotic arms **20**, **22** are replaced by a ring gantry **20'** (drawn in phantom in FIGURE 1) that supports the detector heads **10**, **12**. In these embodiments, the ring gantry **20'** includes a rotatable gantry portion supporting the heads **10**, **12** so as to enable revolving of the heads **10**, **12** around the couch **18**, and gamma detector head mounting fixtures (not shown) provide for radial and tangential movement of the detector heads. Still further, the position sensing apparatuses and methods disclosed herein can be practiced with other medically operative members such as a magnetic resonance scanner, a positron emission tomography (PET) scanner including a ring of detectors, a radiotherapy system, or so forth.

[0021] Having described the gamma camera illustrated in FIGURES 1 and 2 as an example application, illustrative position-determining system embodiments are now described with reference to FIGURES 1 and 2 and with further reference to FIGURES 3-5. The illustrated position-determining systems make use of optically detectable markers disposed on the subject and photosensor arrays disposed on the detector heads **10**, **12**. This configuration advantageously places the photosensor arrays close to the subject during the imaging, and as will be disclosed herein accurate position determination is readily obtained based on light sensed by a plurality of photosensors. Moreover, since the photosensor arrays are mounted on the detector heads **10**, **12**, the same spatial frame-of-reference is employed for both the gamma camera imaging and the position determining system, and accordingly relative positional misalignment between the radiation detector heads and the photosensor arrays is not an issue.

[0022] With continuing reference to FIGURES 1 and 2 and with further reference to FIGURE 3, each detector head **10**, **12** further includes a generally planar array of photosensors **70** disposed on its respective radiation-sensitive face **14**, **16**. One or more optically detectable markers **72** are disposed with a subject **74** placed in the examination region of the gamma camera for imaging. The optically detectable markers **72** can be light emitting diodes (LEDs), reflective markers or phosphorescent markers operating in conjunction with ambient or externally applied light, or so forth, and are disposed with the subject, that is, on the subject directly or indirectly. For example, the optically detectable markers **72** may be disposed indirectly on the subject by being disposed on electrocardiographic leads attached to the subject, or on clothing worn by the subject, or otherwise disposed with the subject. In some embodiments, it is contemplated for the optically detectable markers to be sewn into or otherwise attached with clothing that is worn by the subject. For accurate position determination, it is advantageous for the clothing in such a case to be relatively tight-fitting, that is, tight enough to avoid sagging. The generally planar array of photosensors **70** can be pixelated large-area detectors manufactured using amorphous silicon technology, large-area charge coupled device (CCD) arrays, or so forth.

[0023] Some suitable amorphous silicon-based photosensor arrays are described, for example, in Schiebel et al., "Fluoroscopic x-ray imaging with amorphous silicon thin-film arrays", SPIE vol. 2163 Physics of Medical Imaging (1994) pp. 129-140. The arrays described in Schiebel et al. are coated with a CsI:Tl scintillation layer and an optional white powder reflective light trapping layer to make them sensitive to x-rays. For the present application, the CsI:Tl and white powder layers are suitably omitted, and the optically detectable markers **72** and the array of photosensors **70** are selected for compatibility, that is, the array of photosensors **70** should be sensitive to light emanating from the optically detectable markers **72**. The array of photosensors is optionally coated with a phosphor layer, wavelength-selective reflecting or absorbing layer, or other layer configured to enhance sensitivity to light emitted by, reflected by, or otherwise emanating from the optically detectable markers **72**. As noted previously, the term "light" as used in this application encompasses both visible light and invisible infrared or ultraviolet light. With the CsI:Tl layer omitted, the pixelated amorphous silicon photosensor array layer is substantially transmissive for 511 keV gamma rays detected in PET imaging and for radiation emitted by typical radiopharmaceuticals used in SPECT imaging. Accordingly, placement of the thin array of photosensors **70** between the examination region and the array of radiation detectors **44** is not problematic. The amorphous silicon thin-film photosensor arrays of Schiebel et al. are suitably used on thin plastic sheets, glass, or another base material.

[0024] With reference to FIGURE 1, for determining the positions of one or more optically detectable markers **72** a spatial resolution on the order of between about 0.2 millimeters and 20 millimeters is typically sufficient, although higher or lower resolutions are also contemplated depending upon the application. Optical data collected by the arrays of photosensors **70** on the radiation-sensitive faces **14**, **16** of the detector heads **10**, **12** are temporarily stored in an optical data buffer **80**, and are processed by a position-locating member **82** to generate optical marker positions **84** for the one or more optically detectable markers **72**. Typically, the position-locating member **82** is embodied as electronics such as a processor or controller executing a position-determining algorithm. However, the position-locating member **82** may be otherwise embodied, for example as an analog, digital, or mixed ASIC electronics operating alone or in conjunction with a controller or processor. The generated optical marker positions **84** are suitably used by the image reconstruction member **62** to adjust at least one of the collected data and the reconstructed image based on subject position inferred from the optical marker positions **84**. For example, reconstructed images acquired at different times can be spatially registered by translating, stretching, shrinking, or otherwise transforming the images such that the marker positions are aligned. Alternatively, the imaging data and reconstructed images may be left unadjusted, but subsequent diagnostic information derived from the images may be adjusted based on patient motion known from the generated optical marker positions **84**, or certain imaging data or reconstructed images may be discarded based on problematic patient motion identified based on the generated optical marker positions **84**.

[0025] In the embodiment of FIGURE 3, the photosensors of the array of photosensors **70** are disposed "on top of" the collimator **42**. The photosensors of the array of photosensors **70** in the embodiment of FIGURE 3 have viewing angles effective for a plurality of substantially contiguous photosensors of the array of photosensors **70** to simultaneously sense light from a given optically detectable marker. For example, in FIGURE 3 a contiguous group **CG** of photosensors of the array of photosensors **70** detect light **L** from a nearby one of the optically detectable markers **72**. In the embodiment of FIGURE 3, the position-determining member **82** includes Anger-type logic electronics **82a** that use a centroiding or "Anger-type" logic to determine the position of the nearby optically detectable marker based on relative sensed light intensities of the photosensors of the contiguous group of photosensors **CG** that sense light from the nearby optically detectable marker. Conventional Anger logic is typically used in conjunction with the arrays of photomultiplier tubes **48** of a detector head **10**, **12** (see FIGURE 2) to localize a radiation event on the radiation-sensitive face **14**, **16** of the detector head.

[0026] For the optical application of FIGURE 3, however, it is additionally desired to estimate the distance between the nearby one of the optically detectable markers **72** and the centroid of detection on the array of photosensors **70**. (Mathematically, this amounts to estimating the smallest distance between a point in space corresponding to the optically detectable marker and a plane corresponding to the array of photosensors **70**). The Anger-type logic electronics **82a** suitably estimate this distance based on the absolute sensed light intensities (higher intensity corresponding to a closer marker) and/or based on the size of the contiguous group of sensing photosensors **CG** (larger group size corresponding to a more distant marker). The former approach is computationally straightforward, and can be implemented for example as a look-up table relating absolute intensity (integrated over the contiguous group **CG** of sensing photosensors, or alternatively the absolute intensity at the centroid of the detecting contiguous group **CG**) with distance. The latter approach advantageously is not based on absolute intensity value, and can provide an accurate distance estimate based on a known relative sensitivity-versus-angle profile for the photosensors. For example, assuming an abrupt cutoff angle for the photosensors of "θ" measured off of the array normal, if the contiguous group **CG** is circular with a radius of "x" then the distance "*d*" can be estimated from the relationship $\tan(\theta) = \frac{d}{x}$.

[0027] With reference to FIGURE 4, in another embodiment the viewing angle of the photosensors of the array of photosensors **70** is limited or collimated by the use of an optical collimator **90**. In some embodiments, the optical collimator **90** is embodied as a pair of crossed micro-laminated optical filters such as Vikuiti™ films (available from 3M Company, St. Paul, Minnesota). However, in general any planar collimator that is substantially transmissive for radiation detected by the detector heads **10**, **12** is suitable.

[0028] Because of the collimation, light sensed by the generally planar array of photosensors **70** defines optical projection data (indicated in FIGURE 4 by dashed lines). If two non-parallel planar arrays of photosensors **70** on different detector heads detect the same one of the optically detectable markers **72**, then the optically detectable marker is suitably located at the intersection of the optical projections. Thus, the position-determining member **82** can determine the position of the optically detectable marker based on an intersection of optical projections acquired by the two arrays of photosensors **70**. However, as seen in FIGURE 4 complexity can arise since it is possible for projections to intersect at places where there is no optically detectable marker. (It should be noted that the two-dimensional rendering of FIGURE 4 makes such inadvertent intersections appear much more likely than they actually are in three-dimensional space, where inadvertent intersections will be relatively rare for a small number of optically detectable markers **72**).

[0029] In some embodiments, this complexity is addressed by the position-determining member **82** being embodied as back-projection electronics **82b** that determine the position of the optically detectable markers based on intersections of optical projections by using known backprojection algorithms (or variants such as filtered backprojection, iterative backprojection, or so forth) such as are optionally employed by the reconstruction member **62** to reconstruct SPECT projection data. In another approach, inadvertent intersections are detected based on continuity - as an optically detectable marker moves the corresponding intersection will track it continuously in space and time, whereas an inadvertent intersection of projections will generally be an abrupt event that will disappear once either of the markers generating the inadvertent intersection move.

[0030] With reference to FIGURE 5, in another embodiment the generally planar array of photosensors **70** of each detector head **10**, **12** is disposed "behind" the collimator **42** and in "front" of the array of radiation detectors **44** (see Fig. 2). In other words, the collimator **42** is positioned between the generally planar array of photosensors **70** and the examination region, and the generally planar array of photosensors **70** is positioned between the array of radiation detectors **44** and the collimator **42**. In this way, the collimator **42** provides collimation for both radiation of interest (that is, radiation emitted from the subject and detected by the detector heads **10**, **12** to generate imaging data) and light from the one or more optically detectable markers **72** such that radiation of interest detected by the radiation-sensitive face **14**, **16** defines projection data and light sensed by the generally planar array of photosensors **70** defines optical projection data. The position-determining member **82** is suitably the same as in the embodiment of FIGURE 4, such as for example the illustrated backprojection electronics **82b** configured to reconstruct the optical projection data to determine the position of the one or more optically detectable markers **72** disposed with the subject **74**. In the embodiment of FIGURE 5, if a cosmetic cover (not shown) is disposed over the collimator **42**, then it should be substantially transparent for light emanating from the optically detectable markers **72**.

[0031] In the embodiments of FIGURES 3 and 4, an issue can arise if the collimator **42** is removable. In some gamma camera systems, the collimators **42** of the detector heads **10**, **12** are removable to enable swapping of collimators for different applications. For example, a collimator with relatively larger openings may provide a higher number of radiation counts (effectively translating to higher signal level)) at the expense of reduced collimation and concomitant loss of resolution. A collimator with relatively smaller openings, on the other hand, provides greater collimation and higher resolution, but may reduce the number of received radiation counts. In the embodiments of FIGURES 3 and 4, the generally planar array of photosensors **70** is mounted on the collimator **42** - accordingly, if the collimator **42** is removable then there is preferably a detachable electrical connector (not shown) provided to selectively electrically connect the generally planar array of photosensors **70** with the printed circuit board **50** or other detector head electronics. For example, mating connector parts can be disposed on the collimator **42** and on the detector head such that when the collimator **42** is mounted to the detector head the electrical connection is automatically effectuated. In other embodiments, a manual electrical connection is provided, and the radiologist or other operator intervenes to electrically connect the generally planar array of photosensors **70**.

[0032] With reference to FIGURES 1-5, illustrative embodiments have been described in which the medically operative member is a gamma camera and the array or arrays of photosensors **70** is or are disposed on a radiation-sensitive face or faces of the detector head or heads. More generally, the disclosed position-determining systems are useful in conjunction with substantially any type of medically operative member that substantially occludes from view at least the relevant portion of the subject with which the at least one medically operative member is configured to interact or from which the at least one medically operative member is configured to acquire data. The disclosed position-determining systems are also useful in conjunction with substantially any type of medically operative member that is configured to move respective to the subject during operation of the medically operative member. In such latter cases, the array of photosensors can be advantageously be disposed on the at least one medically operative member so as to move in fixed relative spatial relationship with the at least one medically operative member during operation of the medically operative member. As some additional illustrative examples, the medically operative member can be: (i) a magnetic resonance (MR) scanner, the array of photosensors being disposed on a bore of the MR scanner; (ii) a positron emission tomography (PET) scanner, the array of photosensors being disposed on a bore of the PET scanner; or (iii) a radiation therapy system, the array of photosensors being disposed on or in fixed spatial relation with a radiation emissive member of the radiation therapy system.

[0033] With reference to FIGURE 6, an example is described in which the medically operative member is a magnetic resonance (MR) scanner **100** including a main magnet **101** housed by a housing **102** to generate a static (B_0) magnetic field in a bore **104** of the housing **102**. In some embodiments, the magnet **101** is a superconducting magnet that is disposed in a cryogenic shroud **106**. In other embodiments, a resistive magnet is used and the shroud is optionally omitted. A set of magnetic field gradient windings **108** are disposed on or in the housing **102** to superimpose selected magnetic field gradients on the static (B_0) magnetic field. One or more radio frequency coils are provided to excite and detect magnetic resonance, such as an illustrated whole body birdcage-type radio frequency coil **110** mounted on or in the housing **102**, and/or one or more local radio frequency coils (not shown) disposed in the bore **104** near a region of interest of the subject **74**. The excited and detected magnetic resonance signals are suitably spatially encoded by magnetic field gradients generated by the gradient coil windings **108** to enable reconstruction of an image from the spatially encoded magnetic resonance signals.

[0034] The region to be imaged is preferably substantially centered in the bore **104**, at which bore center the static (B_0) magnetic field and applied magnetic field gradients are typically most uniform. The portion of the subject **74** near the center of the bore **104** is typically substantially occluded from view by the magnetic resonance scanner. Thus, camera-based position-determining systems are difficult or impossible to use in this setting.

[0035] Accordingly, as shown in FIGURE 6, an array of photosensors **170** is disposed on an inner surface of the generally cylindrical bore **104** so as to view the examination region in the bore **104**, and one or more optically detectable markers **172**, such as LEDs, reflective spheres, or so forth, are disposed with the portion of the subject **74** to be imaged, that is, directly or indirectly on the subject. For example, the optically detectable markers **172** in some embodiments may be disposed on a local radio frequency coil (not shown) that in turn is disposed on or secured to the subject **74**. The array of photosensors **170** is suitably an amorphous silicon-based photosensor array such as is described, for example, in Schiebel et al., or an array of CCD devices, or so forth. The illustrated array of photosensors **170** is a generally annular array encircling the subject **74**, thus advantageously providing 360° viewing. In other embodiments, a hemispherical or otherwise-shaped array of photosensors may be used. In embodiments in which the photosensors are amorphous silicon-based and the substrate is a flexible plastic material, the illustrated annular array can be constructed using annular sheets of photosensor arrays. On the other hand, if a rigid substrate such as glass is used, then the annular array of photosensors **170** can be constructed of a plurality of adjacent planar segments arranged to approximate an annular shape. The array of photosensors **170** and the one or more optically detectable markers **172** are made of non-magnetic materials such as amorphous silicon, gallium arsenide or other group III-arsenide materials, gallium nitride or other group III-nitride materials, or so forth. Both plastic and glass substrates can be made suitably non- magnetic.

[0036] The position-determining system employing the array of photosensors **170** and the one or more optically detectable markers **172** can be operated similarly to the corresponding systems mounted on a gamma camera described with reference to FIGURES 1-4. For example, wide viewing angle photosensors can be used in conjunction with the Anger-type logic electronics **82a** analogous to the gamma camera embodiments described with reference to FIGURE 3, or collimated photosensors can be used in conjunction with backprojection electronics **82b** or another projection-intersection based position locating member analogous to the gamma camera embodiments described with reference to FIGURE 4. In the latter case, the annular shape of the array of photosensors **170** advantageously provides a large viewing angle span that facilitates accurate position determination for the one or more optically detectable markers **172**.

[0037] Gamma camera and magnetic resonance scanner embodiments are illustrated as examples. As another example, the medically operative member can be a PET scanner with a ring of detectors, and the photosensors can be disposed on the detector ring, for example as an annular array of photosensors. Moreover, while the application of tracking subject motion has been described as an illustrative application, the position determining systems and methods disclosed herein can be used for other applications. For example, if the optically detectable markers are kept in place on the subject as the subject is moved from one imaging modality to different imaging modality, and both imaging modalities have suitable photosensors and position-determining members to determine the positions of the optically detectable markers, then this information can be used to spatially register images acquired by the two imaging modalities. For example, if the subject is imaged by both the gamma camera of FIGURE 1 and the magnetic resonance scanner of FIGURE 6, and the optically detectable markers **72**, **172** are identical, then the marker positions determined by the position determining systems of the gamma camera and magnetic resonance scanner can be used to spatially register the SPECT and magnetic resonance images acquired by the gamma camera and magnetic resonance scanner, respectively.

[0038] The preferred embodiments have been described. 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.

Claims

1. A medical imaging arrangement comprising:

at least one medically operative member **(10, 12, 100)** being able to interact with or acquire data from a subject **(74)** disposed in an examination region;
a two-dimensional array of photosensors **(70, 170)** disposed on the at least one medically operative member, the array of photosensors arranged to view the examination region, wherein the at least one medically operative member **(10, 12, 100)** comprises a) at least one radiation detector **(10, 12)** having a radiation-sensitive face **(14, 16)** configured to detect radiation of interest, the array of photosensors **(70)** being generally planar and arranged parallel with the radiation-sensitive face, or b) a medical imaging system **(100)** including a generally cylindrical bore **(104)** surrounding the examination region, the array of photosensors **(170)** being disposed on an inner surface of the generally cylindrical bore so as to view the examination region; and
a position-determining member **(82, 82a, 82b)** configured to determine a position of at least one optically detectable marker **(72, 172)** disposed with the subject in the examination region based on light from the at least one optically detectable marker sensed by the array of photosensors.

2. The medical imaging arrangement as set forth in claim **1**, further comprising: said at least one optically detectable marker **(72, 172)** comprising a light-emitting marker configured to be disposed with the subject **(74)** in the examination region.

3. The medical imaging arrangement as set forth in claim **1**, further comprising:

a collimator **(42)** mounted on the radiation-sensitive face **(14, 16)** of the at least one radiation detector **(12, 14)** and disposed between the generally planar array of photosensors **(70)** and the examination region to collimate both radiation of interest and light such that radiation of interest detected by the radiation-sensitive face defines projection data and light sensed by the generally planar array of photosensors defines optical projection data, the position-determining member **(82b)** comprising electronics configured to reconstruct the optical projection data to determine the position of the at least one optically detectable marker disposed with the subject.

4. The medical imaging arrangement as set forth in claim **3**, wherein the at least one radiation detector comprises a plurality of movable detector heads **(10, 12)** and the electronics are configured to reconstruct the combined optical projection data from the generally planar arrays of photosensors **(70)** disposed on the radiation-sensitive faces **(14, 16)** of the plurality of detector heads.

5. The medical imaging arrangement as set forth in claim **1**, further comprising:

a collimating microlaminated optical filter **(90)** disposed between the generally planar array of photosensors **(70)** and the examination region to collimate a viewing angle of the photosensors such that light sensed by the generally planar array of photosensors defines optical projection data, the position-determining member **(82b)** comprising electronics configured to reconstruct the optical projection data to determine the position of the at least one optically detectable marker **(72, 172)** disposed with the subject **(74)**.

6. The medical imaging arrangement as set forth in claim **1**, wherein the photosensors have a viewing angle effective for a substantially contiguous group of photosensors **(CG)** of the array of photosensors **(70)** to simultaneously sense light from a nearby optically detectable marker, and the position-determining member comprises: electronics **(82a)** configured to determine the position of the nearby optically detectable marker based on relative sensed light intensities of the substantially contiguous group of photosensors of the array of photosensors.

7. The medical imaging arrangement as set forth in any one of claims **1 to 6**, wherein the at least one medically operative member is selected from a group consisting of: (i) a detector head **(10, 12)** of a gamma camera, the array of photosensors **(70)** being disposed on a radiation-sensitive face **(14, 16)** of the detector head; (ii) a magnetic resonance (MR) scanner **(100),** the array of photosensors **(170)** being disposed on a bore **(104)** of the MR scanner; (iii) a positron emission tomography (PET) scanner, the array of photosensors being disposed on a detector ring of the PET scanner; and (iv) a radiation therapy system, the array of photosensors being disposed on or in fixed spatial relation with a radiation emissive member of the radiation therapy system.

8. The medical imaging arrangement as set forth in any one of claims **1 to 7**, further comprising:

a collimating member **(42, 90)** disposed between the array of photosensors **(70, 170)** and the examination region to collimate a viewing angle of the photosensors such that light sensed by the array of photosensors defines optical projection data, the position-determining member comprising electronics **(82b)** configured to determine the position of the at least one optically detectable marker **(72, 172)** based on the optical projection data.

9. The medical imaging arrangement as set forth in any one of claims **1 to 8**, wherein the position-determining member comprises:

electronics **(82a)** configured to determine the position of the at least one optically detectable marker **(72, 172)** based on analysis of light intensities sensed by a contiguous group of photosensors **(CG)** of the array of photosensors **(70, 170)**.

10. The medical imaging arrangement as set forth in any one of the preceding claims, wherein the at least one radiation detector head **(10, 12)** or the medical imaging system **(100)** is configured to collect data from the subject **(74)** and the medical imaging arrangement further comprises an image reconstruction member **(62)** configured to reconstruct an image of at least a portion of the subject based on the collected data, the image reconstruction member being further configured to adjust at least one of the collected data and the reconstructed image based on subject position inferred from the optical marker position **(84)** of the at least one optically detectable marker **(72, 172)** determined by the position-determining member.

11. The medical imaging arrangement as set forth in any one of the preceding claims, wherein the at least one medically operative member **(10, 12)** is configured to move respective to the subject **(74)** during operation of the medically operative member, and the array of photosensors **(70)** disposed on the at least one medically operative member is configured to move in fixed relative spatial relationship with the at least one medically operative member during operation of the medically operative member.

12. A position measurement method for use with a medical imaging arrangement comprising the steps of:

detecting at least one optically detectable marker **(72, 172)** disposed on a subject **(74)** in an examination region using a two-dimensional array of photosensors **(70, 170)** disposed on a medically operative member **(10, 12, 100)** being able to interact with or acquire data from the subject in the examination region, wherein the medically operative member **(10, 12, 100)** comprises a) at least one radiation detector **(10, 12)** having a radiation-sensitive face **(14, 16)** configured to detect radiation of interest, the array of photosensors **(70)** being generally planar and arranged parallel with the radiation-sensitive face, or b) a medical imaging system **(100)** including a generally cylindrical bore **(104)** surrounding the examination region, the array of photosensors **(170)** being disposed on an inner surface of the generally cylindrical bore so as to view the examination region; determining at least one optical marker position **(84)** corresponding to the at least one optically detectable marker based on the detecting; and
repeating the detecting and determining steps a plurality of times to track motion of the at least one optical marker position **(84)** over time.

Patentansprüche

1. Medizinische Bildgebungsanordnung, umfassend:

mindestens ein medizinisch funktionsfähiges Element (10, 12, 100), das in der Lage ist, mit einem in einer Untersuchungsregion angeordneten Subjekt (74) zu interagieren oder Daten hiervon zu erfassen;
ein zweidimensionales Array von Fotosensoren (70, 170), die auf dem mindestens einen medizinisch funktionsfähigen Element angeordnet sind, wobei das Array von Fotosensoren dafür vorgesehen ist, die Untersuchungsregion anzusehen, wobei das mindestens eine medizinisch funktionsfähige Element (10, 12, 100) a) mindestens einen Strahlungsdetektor (10, 12) mit einer strahlungsempfindlichen Stirnseite (14, 16) umfasst, die dafür konfiguriert ist, interes-

sierende Strahlung zu detektieren, wobei das Array von Fotosensoren (70) im Allgemeinen planar und parallel zu der strahlungsempfindlichen Stirnseite angeordnet ist, oder b) ein medizinisches Bildgebungssystem (100) einschließlich einer die Untersuchungsregion umgebenden zylindrischen Bohrung (104) umfasst, wobei das Array von Fotodetektoren (170) auf einer Innenfläche der im Allgemeinen zylindrischen Bohrung angeordnet ist, um so die Untersuchungsregion zu sehen; und
ein positionsbestimmendes Element (82, 82a, 82b), das dafür konfiguriert ist, eine Position von mindestens einem optisch detektierbaren Marker (72, 172), der mit dem Subjekt in der Untersuchungsregion angeordnet ist, basierend auf dem durch das Array von Fotosensoren erfassten Licht von dem mindestens einen optisch detektierbaren Marker zu bestimmen.

2. Medizinische Bildgebungsanordnung nach Anspruch 1, weiterhin umfassend: den genannten mindestens einen optisch detektierbaren Marker (72, 172) umfassend einen lichtemittierenden Marker, der dafür konfiguriert ist, mit dem Subjekt (74) in der Untersuchungsregion angeordnet zu werden.

3. Medizinische Bildgebungsanordnung nach Anspruch 1, weiterhin umfassend:

einen Kollimator (42), der an der strahlungsempfindlichen Stirnfläche (14, 16) des mindestens einen Strahlungsdetektors (12, 14) montiert und zwischen dem im Allgemeinen planaren Array von Fotosensoren (70) und der Untersuchungsregion angeordnet ist, um sowohl interessierende Strahlung als auch Licht zu kollimieren, sodass durch die strahlungsempfindliche Stirnfläche detektierte interessierende Strahlung Projektionsdaten definiert und durch das im Allgemeinen planare Array von Fotosensoren erfasste Licht optische Projektionsdaten definiert, wobei das positionsbestimmende Element (82b) Elektronik umfasst, die dafür konfiguriert ist, die optischen Projektionsdaten zu rekonstruieren, um die Position des mindestens einen mit dem Subjekt angeordneten optisch detektierbaren Markers zu bestimmen.

4. Medizinische Bildgebungsanordnung nach Anspruch 3, wobei der mindestens eine Strahlungsdetektor eine Vielzahl von beweglichen Detektorköpfen (10, 12) umfasst und die Elektronik dafür konfiguriert ist, die kombinierten optischen Projektionsdaten von den im Allgemeinen planaren Arrays von Fotosensoren (70) zu rekonstruieren, die auf den strahlungsempfindlichen Stirnflächen (14, 16) der Vielzahl von Detektorköpfen angeordnet sind.

5. Medizinische Bildgebungsanordnung nach Anspruch 1, weiterhin umfassend:

einen kollimierenden mikrolaminierten optischen Filter (90), der zwischen dem im Allgemeinen planaren Array von Fotosensoren (70) und der Untersuchungsregion angeordnet ist, um einen Sichtwinkel der Fotosensoren derartig zu kollimieren, dass durch das im Allgemeinen planare Array von Fotosensoren erfasstes Licht optische Projektionsdaten definiert, wobei das positionsbestimmende Element (82b) Elektronik umfasst, die konfiguriert ist, um die optischen Projektionsdaten zu rekonstruieren, um die Position des mindestens einen mit dem Subjekt (74) angeordneten optisch detektierbaren Markers (72, 172) zu bestimmen.

6. Medizinische Bildgebungsanordnung nach Anspruch 1, wobei die Fotosensoren einen Sichtwinkel haben, der für eine im Wesentlichen zusammenhängende Gruppe von Fotosensoren (CG) des Arrays von Fotosensoren (70) wirksam ist, um gleichzeitig Licht aus einem in der Nähe befindlichen optisch detektierbaren Marker zu erfassen, und wobei das positionsbestimmende Element umfasst: Elektronik (82a), die dafür konfiguriert ist, die Position des in der Nähe befindlichen optisch detektierbaren Markers basierend auf relativen erfassten Lichtintensitäten der im Wesentlichen zusammenhängenden Gruppe von Fotosensoren des Arrays von Fotosensoren zu bestimmen.

7. Medizinische Bildgebungsanordnung nach einem der Ansprüche 1 bis 6, wobei das mindestens eine medizinisch funktionsfähige Element ausgewählt wird aus der Gruppe bestehend aus: (i) einem Detektorkopf (10, 12) einer Gammakamera, wobei das Array von Fotosensoren (70) auf einer strahlungsempfindlichen Stirnfläche (14, 16) des Detektorkopfs angeordnet ist; (ii) einem Magnetresonanz-Scanner (MR-Scanner) (100), wobei das Array von Fotosensoren (170) an einer Bohrung (104) des MR-Scanners angeordnet ist; (iii) einem Positronenemissions-Tomographie-Scanner (PET-Scanner), wobei das Array von Fotosensoren auf einem Detektorring des PET-Scanners angeordnet ist; und (iv) einem Strahlentherapiesystem, wobei das Array von Fotosensoren an oder in fester räumlicher Beziehung zu einem strahlungsempfindlichen Element des Strahlentherapiesystems angeordnet ist.

8. Medizinische Bildgebungsanordnung nach einem der Ansprüche 1 bis 7, weiterhin umfassend:

ein kollimierendes Element (42, 90), das zwischen dem Array von Fotosensoren (70, 170) und der Untersuchungsregion angeordnet ist, um einen Sichtwinkel der Fotosensoren derartig zu kollimieren, dass durch das Array von Fotosensoren erfasstes Licht optische Projektionsdaten definiert, wobei das positionsbestimmende Element Elektronik (82b) umfasst, die dafür konfiguriert ist, die Position des mindestens einen optisch detektierbaren Markers (72, 172) basierend auf den optischen Projektionsdaten zu bestimmen.

9. Medizinische Bildgebungsanordnung nach einem der Ansprüche 1 bis 8, wobei das positionsbestimmende Element Folgendes umfasst:

Elektronik (82a), die dafür konfiguriert ist, die Position des mindestens einen optisch detektierbaren Markers (72, 172) basierend auf der Analyse von Lichtintensitäten zu ermitteln, die durch eine zusammenhängende Gruppe von Fotosensoren (CG) des Arrays von Fotosensoren (70, 170) erfasst wurden.

10. Medizinische Bildgebungsanordnung nach einem der vorhergehenden Ansprüche, wobei der mindestens eine Strahlungsdetektorkopf (10, 12) oder das medizinische Bildgebungssystem (100) dafür konfiguriert ist, Daten von dem Subjekt (74) zu sammeln, und wobei die medizinische Bildgebungsanordnung weiterhin ein Bildrekonstruktionselement (62) umfasst, das dafür konfiguriert ist, ein Bild von mindestens einem Teil des Subjekts basierend auf den gesammelten Daten zu rekonstruieren, wobei das Bildrekonstruktionselement weiterhin dafür konfiguriert ist, mindestens entweder die gesammelten Daten oder das rekonstruierte Bild basierend auf der Subjektposition anzupassen, die von der optischen Markerposition (84) des mindestens einen optisch detektierbaren Markers (72, 172) abgeleitet wird, die durch das positionsbestimmende Element bestimmt wird.

11. Medizinische Bildgebungsanordnung nach einem der vorhergehenden Ansprüche, wobei das mindestens eine medizinisch funktionsfähige Element (10, 12) dafür konfiguriert ist, sich in Bezug auf das Subjekt (74) während des Betriebs des medizinisch funktionsfähigen Elements zu bewegen, und wobei das auf dem mindestens einen medizinisch funktionsfähigen Element angeordnete Array von Fotosensoren (70) dafür konfiguriert ist, sich während des Betriebs des medizinisch funktionsfähigen Elements in fester relativer räumlicher Beziehung zu dem mindestens einen medizinisch funktionsfähigen Element zu bewegen.

12. Positionsmessverfahren zur Verwendung mit der medizinischen Bildgebungsanordnung, das die folgenden Schritte umfasst:

Detektieren von mindestens einem optisch detektierbaren Marker (72, 172), der auf einem Subjekt (74) in einer Untersuchungsregion angeordnet ist, mithilfe eines zweidimensionalen Arrays von Fotosensoren (70, 170), die auf einem medizinisch funktionsfähigen Element (10, 12, 100) angeordnet sind, das in der Lage ist, mit dem Subjekt in der Untersuchungsregion zu interagieren oder Daten von diesem zu erfassen, wobei das medizinisch funktionsfähige Element (10, 12, 100) a) mindestens einen Strahlungsdetektor (10, 12) mit einer strahlungsempfindlichen Stirnseite (14, 16) umfasst, die dafür konfiguriert ist, interessierende Strahlung zu detektieren, wobei das Array von Fotosensoren (70) im Allgemeinen planar und parallel zu der strahlungsempfindlichen Stirnseite angeordnet ist, oder b) ein medizinisches Bildgebungssystem (100) einschließlich einer die Untersuchungsregion umgebenden zylindrischen Bohrung (104) umfasst, wobei das Array von Fotodetektoren (170) auf einer Innenfläche der im Allgemeinen zylindrischen Bohrung angeordnet ist, um so die Untersuchungsregion zu sehen;
Bestimmen von mindestens einer optischen Markerposition (84), die dem mindestens einen optisch detektierbaren Marker entspricht, basierend auf dem Detektieren; und
mehrmaliges Wiederholen der Schritte des Detektierens und Bestimmens, um Bewegung der mindestens einen optischen Markerposition (84) über die Zeit zu verfolgen.

Revendications

1. Agencement d'imagerie médicale comprenant :

au moins un organe de fonctionnement médical (10, 12, 100) pouvant interagir avec ou acquérir des données provenant d'un sujet (74) disposé dans une région d'examen ;
un réseau bidimensionnel de photo-capteurs (70, 170) disposé sur l'au moins un organe de fonctionnement médical, le réseau de photo-capteurs étant agencé pour voir la région d'examen, dans lequel l'au moins un organe de fonctionnement médical (10, 12, 100) comprend a) au moins un détecteur de rayonnement (10, 12) ayant une face sensible au rayonnement (14, 16) configurée pour détecter un rayonnement d'intérêt, le réseau de photo-capteurs (70) étant globalement plan et agencé parallèlement à la face sensible au rayonnement, ou b) un système d'imagerie médicale (100) incluant un trou globalement cylindrique (104) entourant la région d'examen, le réseau de photo-capteurs (170) étant disposé sur une surface intérieure du trou

globalement cylindrique de manière à voir la région d'examen ; et
un organe de détermination de position (82, 82a, 82b) configuré pour déterminer une position d'au moins un marqueur optiquement détectable (72, 172) disposé avec le sujet dans la région d'examen sur la base d'une lumière provenant de l'au moins un marqueur optiquement détectable captée par le réseau de photo-capteurs.

2. Agencement d'imagerie médicale selon la revendication 1, comprenant en outre : ledit au moins un marqueur optiquement détectable (72, 172) comprenant un marqueur d'émission de lumière configuré pour être disposé avec le sujet (74) dans la région d'examen.

3. Agencement d'imagerie médicale selon la revendication 1, comprenant en outre :

un collimateur (42) monté sur la face sensible au rayonnement (14, 16) de l'au moins un détecteur de rayonnement (12, 14) et disposé entre le réseau globalement plan de photo-capteurs (70) et la région d'examen pour collimater à la fois un rayonnement d'intérêt et la lumière de telle sorte que le rayonnement d'intérêt détecté par la face sensible au rayonnement définit des données de projection et la lumière captée par le réseau globalement plan de photo-capteurs définit des données de projection, l'organe de détermination de position (82b) comprenant de l'électronique configurée pour reconstruire les données de projection optique afin de déterminer la position de l'au moins un marqueur optiquement détectable disposé avec le sujet.

4. Agencement d'imagerie médicale selon la revendication 3, dans lequel l'au moins un détecteur de rayonnement comprend une pluralité de têtes de détecteur mobiles (10, 12) et l'électronique est configurée pour reconstruire les données de projection optique combinées provenant des réseaux globalement plans de photo-capteurs (70) disposés sur les faces sensibles au rayonnement (14,16) de la pluralité de têtes de détecteur.

5. Agencement d'imagerie médicale selon la revendication 1, comprenant en outre :

un filtre optique micro-stratifié de collimation (90) disposé entre le réseau globalement plan de photo-capteurs (70) et la région d'examen pour collimater un angle de vue des photo-capteurs de telle sorte que la lumière captée par le réseau globalement plan de photo-capteurs définit des données de projection optique, l'organe de détermination de position (82b) comprenant de l'électronique configurée pour reconstruire les données de projection optique afin de déterminer la position de l'au moins un marqueur optiquement détectable (72, 172) disposé avec le sujet (74).

6. Agencement d'imagerie médicale selon la revendication 1, dans lequel les photo-capteurs ont un angle de vue efficace pour un groupe sensiblement contigu de photo-capteurs (CG) du réseau de photo-capteurs (70) afin de capter simultanément la lumière provenant d'un marqueur optiquement détectable voisin, et l'organe de détermination de position comprend : de l'électronique (82a) configurée pour déterminer la position du marqueur optiquement détectable voisin sur la base d'intensités lumineuses captées relatives du groupe sensiblement contigu de photo-capteurs du réseau de photo-capteurs.

7. Agencement d'imagerie médicale selon l'une quelconque des revendications 1 à 6, dans lequel l'au moins un organe de fonctionnement médical est sélectionné dans un groupe constitué : (i) d'une tête de détecteur (10, 12) d'une caméra gamma, le réseau de photo-capteurs (70) étant disposé sur une face sensible au rayonnement (14, 16) de la tête de détecteur ; (ii) d'un appareil d'imagerie par résonance magnétique (RM) (100), le réseau de photo-capteurs (170) étant disposé sur un trou (104) de l'appareil d'imagerie RM ; (iii) d'un appareil d'imagerie à tomographie par émission de positons (PET), le réseau de photo-capteurs étant disposé sur une bague de détecteur de l'appareil d'imagerie PET ; et (iv) d'un système de thérapie par rayonnement, le réseau de photo-capteurs étant disposé sur ou dans une relation spatiale fixe avec un organe d'émission de rayonnement du système de thérapie par rayonnement.

8. Agencement d'imagerie médicale selon l'une quelconque des revendications 1 à 7, comprenant en outre :

un organe de collimation (42, 90) disposé entre le réseau de photo-capteurs (70, 170) et la région d'examen pour collimater un angle de vue des photo-capteurs de telle sorte que la lumière captée par le réseau de photo-capteurs définit des données de projection optique, l'organe de détermination de position comprenant de l'électronique (82b) configurée pour déterminer la position de l'au moins un marqueur optiquement détectable (72, 172) sur la base des données de projection optique.

9. Agencement d'imagerie médicale selon l'une quelconque des revendications 1 à 8, dans lequel l'organe de détermination de position comprend :

de l'électronique (82a) configurée pour déterminer la position de l'au moins un marqueur optiquement détectable (72, 172) sur la base d'une analyse d'intensités lumineuses captées par un groupe contigu de photo-capteurs (CG) du réseau de photo-capteurs (70, 170).

10. Agencement d'imagerie médicale selon l'une quelconque des revendications précédentes, dans lequel l'au moins une tête de détecteur de rayonnement (10, 12) ou le système d'imagerie médicale (100) est configuré pour collecter des données provenant du sujet (74) et l'agencement d'imagerie médicale comprend en outre un organe de reconstruction d'image (62) configuré pour reconstruire une image d'au moins une portion du sujet sur la base des données collectées, l'organe de reconstruction d'image étant en outre configuré pour ajuster au moins l'une parmi les données collectées et l'image reconstruite sur la base de position de sujet déduite de la position de marqueur optique (84) de l'au moins un marqueur optiquement détectable (72, 172) déterminée par l'organe de détermination de position.

11. Agencement d'imagerie médicale selon l'une quelconque des revendications précédentes, dans lequel l'au moins un organe de fonctionnement médical (10, 12) est configuré pour se déplacer par rapport au sujet (74) durant le fonctionnement de l'organe de fonctionnement médical, et le réseau de photo-capteurs (70) disposé sur l'au moins un organe de fonctionnement médical est configuré pour se déplacer dans une relation spatiale relative fixe avec l'au moins un organe de fonctionnement médical pendant le fonctionnement de l'organe de fonctionnement médical.

12. Procédé de mesure de position à utiliser avec un agencement d'imagerie médicale comprenant les étapes consistant à :

détecter au moins un marqueur optiquement détectable (72, 172) disposé sur un sujet (74) dans une région d'examen en utilisant un réseau bidimensionnel de photo-capteurs (70, 170) disposé sur un organe de fonctionnement médical (10, 12, 100) capable d'interagir avec ou d'acquérir des données provenant du sujet dans la région d'examen, dans lequel l'organe de fonctionnement médical (10, 12, 100) comprend a) au moins un détecteur de rayonnement (10, 12) ayant une face sensible au rayonnement (14, 16) configurée pour détecter un rayonnement d'intérêt, le réseau de photo-capteurs (70) étant globalement plan et agencé parallèlement à la face sensible au rayonnement, ou b) un système d'imagerie médicale (100) incluant un trou globalement cylindrique (104) entourant la région d'examen, le réseau de photo-capteurs (170) étant disposé sur une surface intérieure du trou globalement cylindrique de manière à voir la région d'examen ;

déterminer au moins une position de marqueur optique (84) correspondant à l'au moins un marqueur optiquement détectable sur la base de la détection ; et

répéter les étapes de détection et de détermination plusieurs fois pour suivre le mouvement de l'au moins une position de marqueur optique (84) avec le temps.

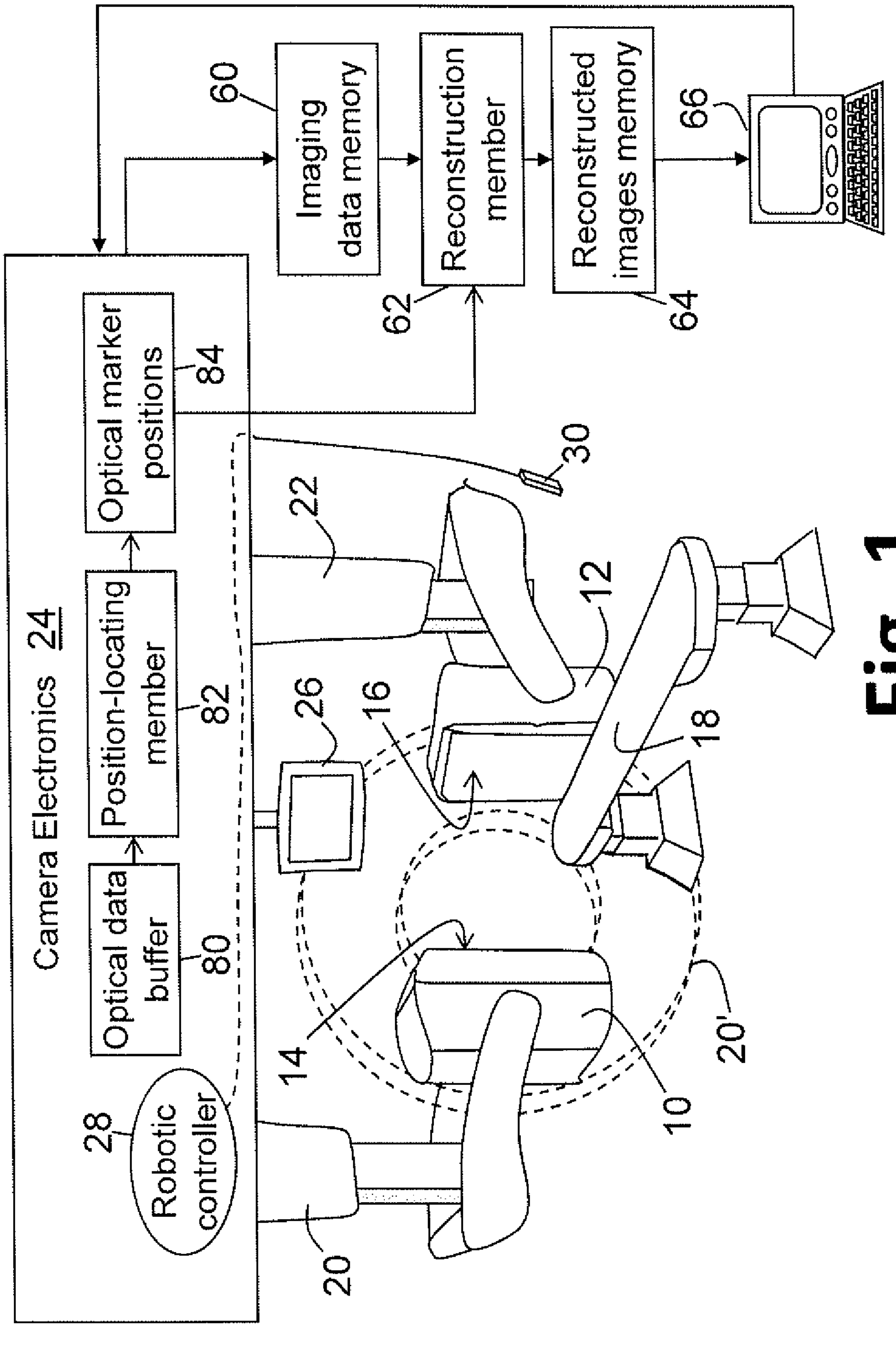
Camera Electronics 24
Robotic controller
28
Optical data buffer
80
Position-locating member
82
Optical marker positions
84
Imaging data memory
60
Reconstruction member
62
Reconstructed images memory
64
66
30
22
12
26
16
18
14
10
20'
20

Fig. 1

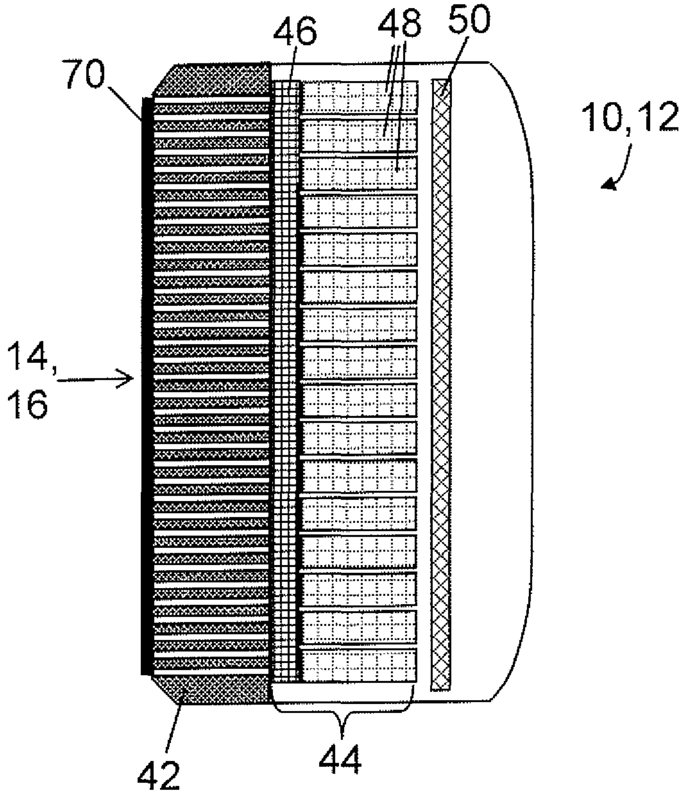

Fig. 2

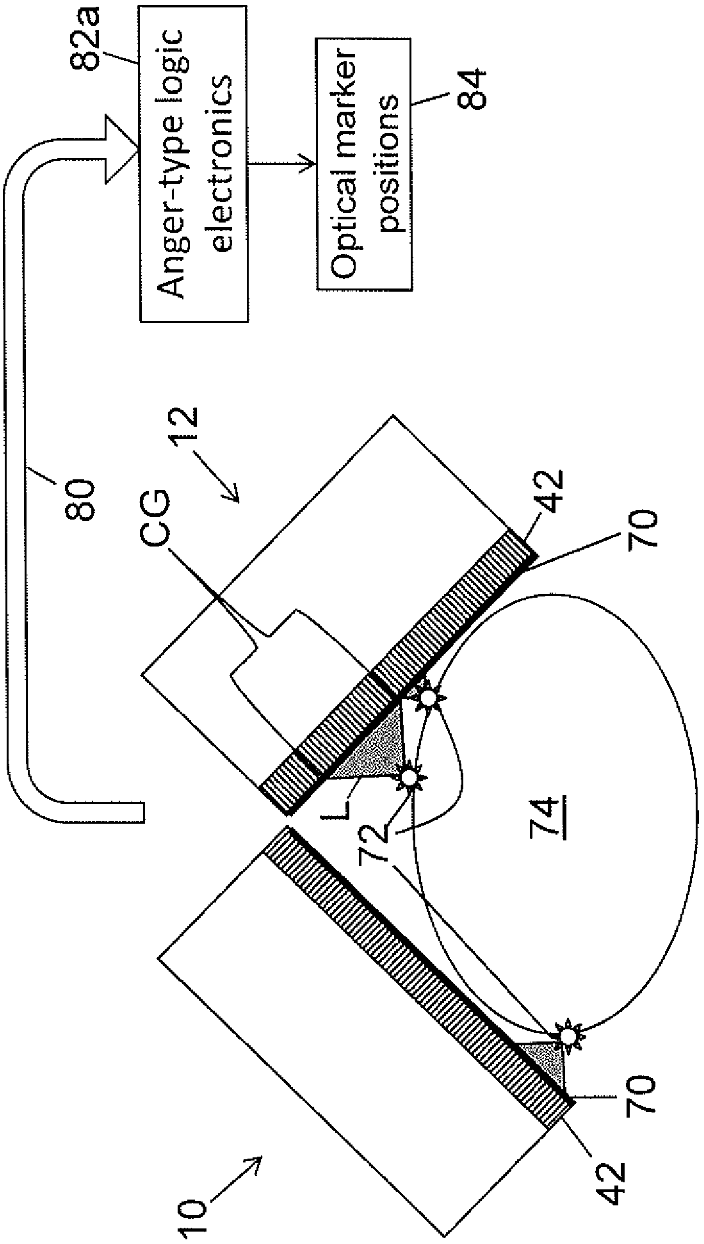
82a
Anger-type logic electronics
Optical marker positions
84
80
12
CG
42
70
L
72
74
42
70
10

Fig. 3

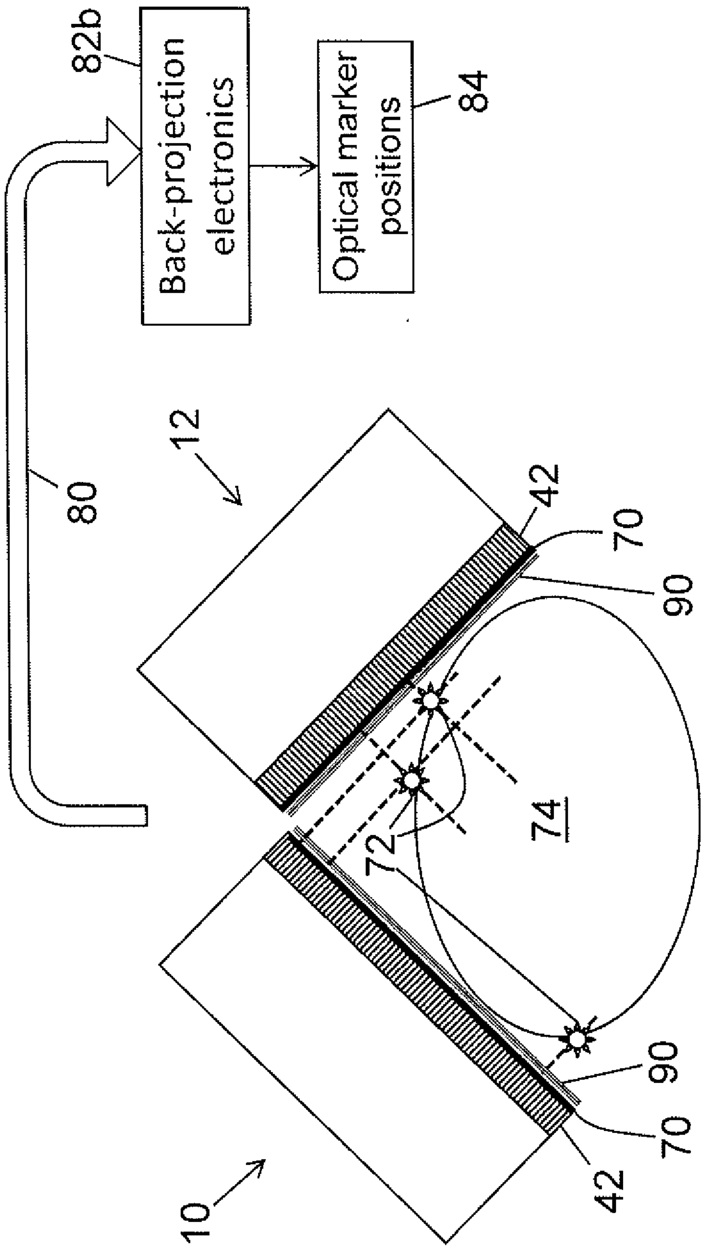
82b
Back-projection electronics
Optical marker positions
84
80
12
42
70
90
72
74
90
70
42
10

Fig. 4

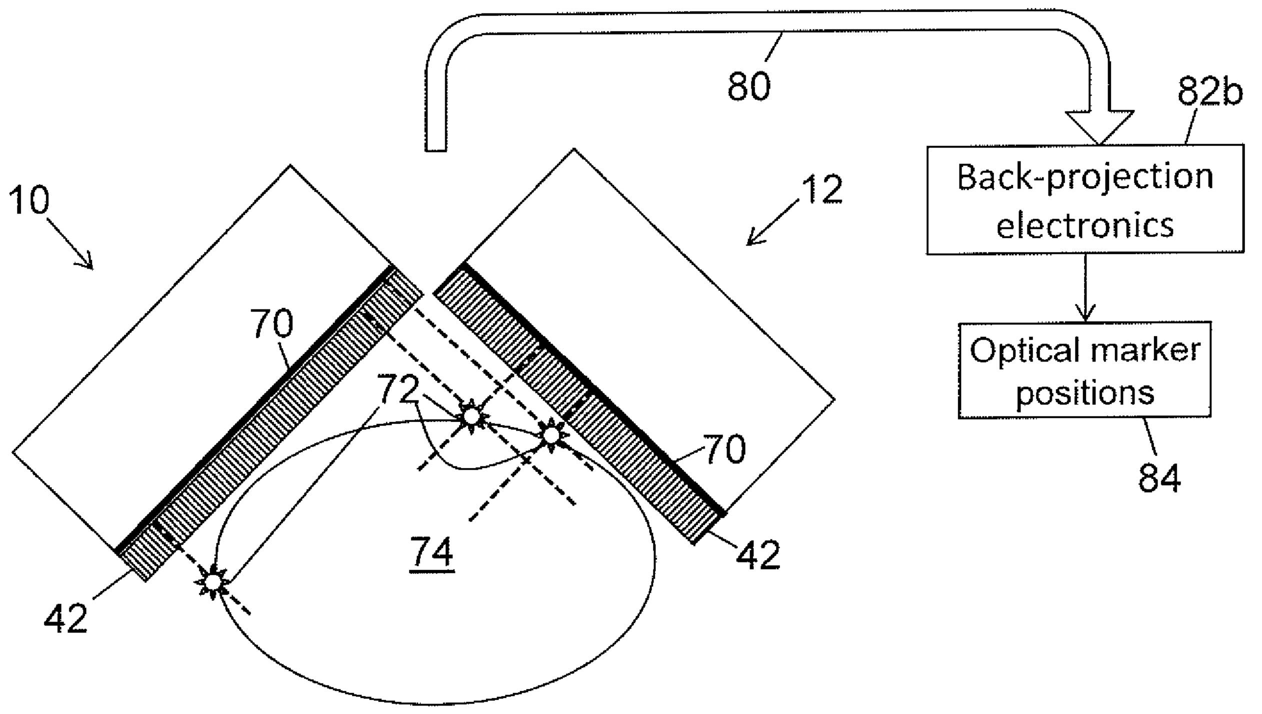
80
82b
Back-projection electronics
Optical marker positions
84
10
12
70
72
70
42
74
42

Fig. 5

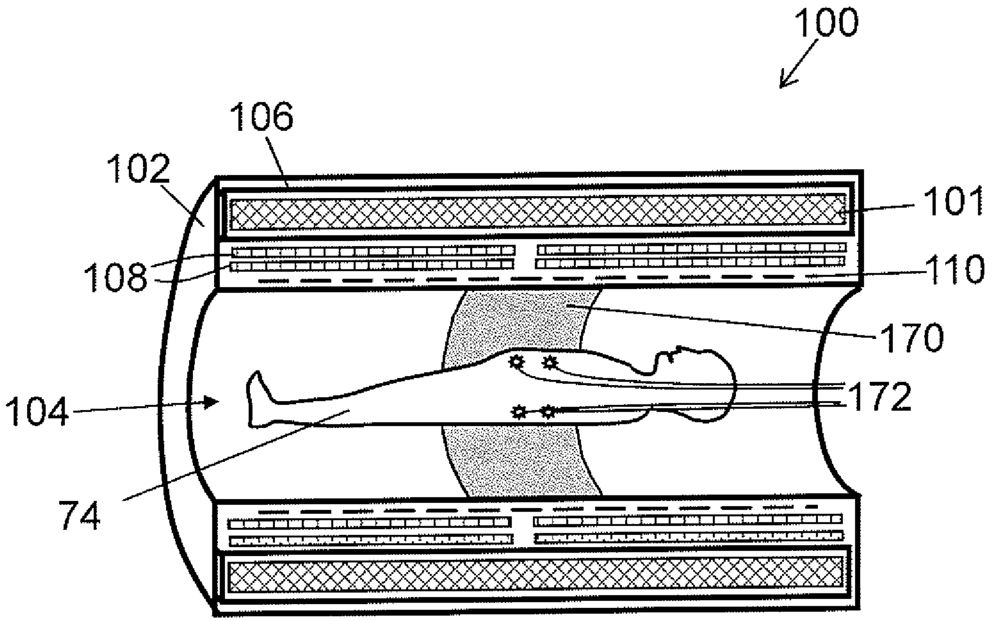

Fig. 6

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- US 7209759 B **[0006]**

Non-patent literature cited in the description

- **R.D. BEACH et al.** Feasibility of stereo-infrared tracking to monitor patient motion during cardiac SPECT imaging. *IEEE Trans. Nucl. Sci.,* 2004, vol. 51, 2693-2698 **[0004]**
- **SCHIEBEL et al.** Fluoroscopic x-ray imaging with amorphous silicon thin-film arrays. *SPIE vol. 2163 Physics of Medical Imaging,* 1994, vol. 2163, 129-140 **[0023]**

专利名称(译)	医疗系统中的运动检测		
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摘要(译)

在医疗系统中，至少一个医疗手术构件（10,12,100）被配置成与设置在检查区域中的对象（74）相互作用或从其获取数据。一组光电传感器（70,170）设置在至少一个医疗操作构件上。光电传感器阵列被布置为观察检查区域。位置确定构件（82,82a，82b）被配置成基于来自所感测的至少一个光学可检测标记的光来确定与检查区域中的对象一起设置的至少一个光学可检测标记（72,172）的位置。由光电传感器组成。