FIG.1

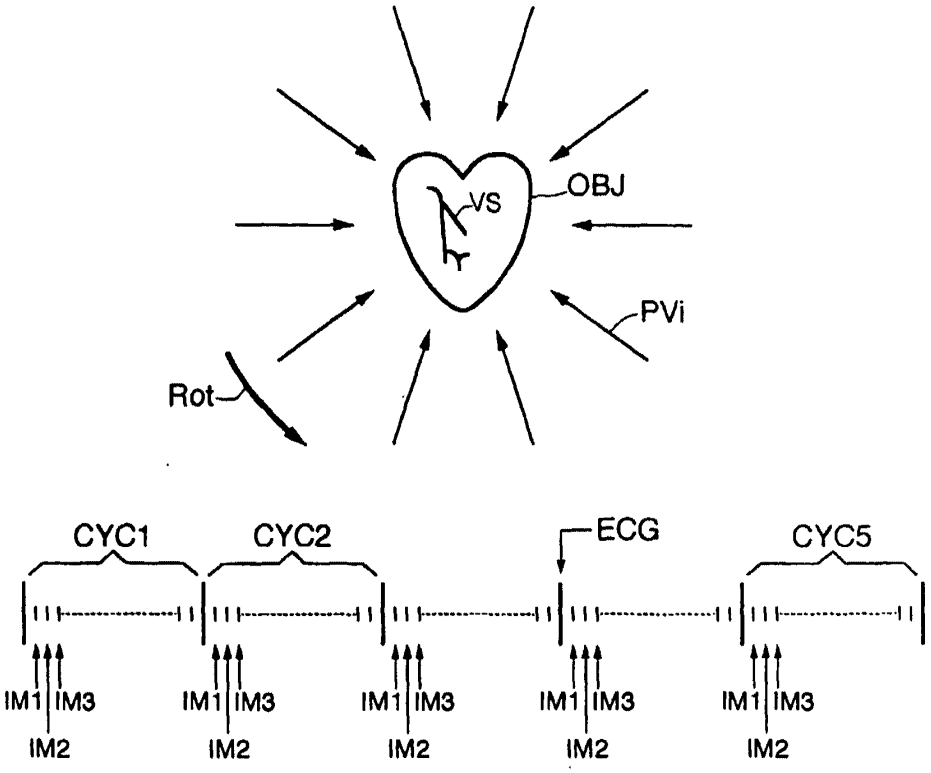
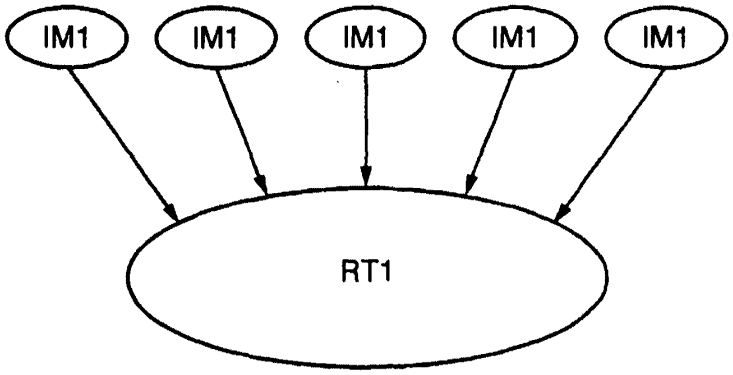


FIG.2



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FIG.3

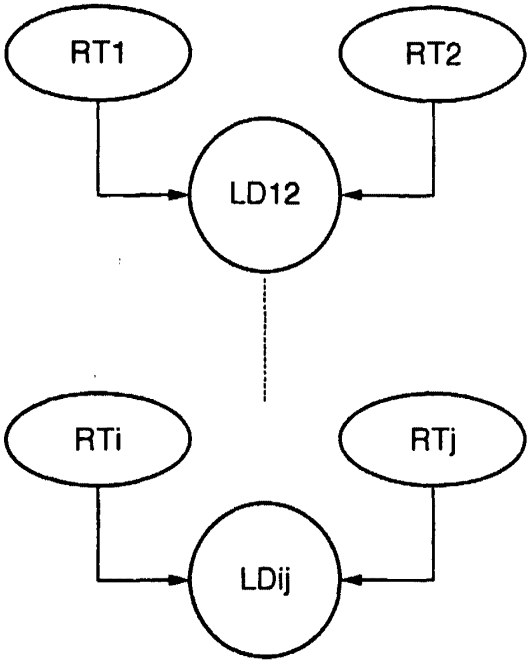
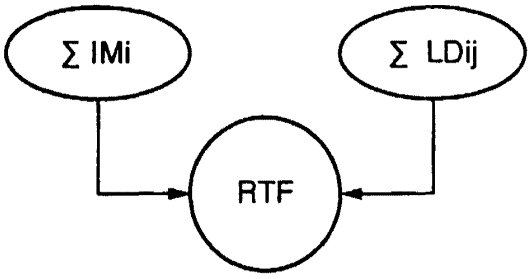


FIG.4



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 30 7918

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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G06T

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	2 November 2000	Perez Molina, E

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

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02-11-2000

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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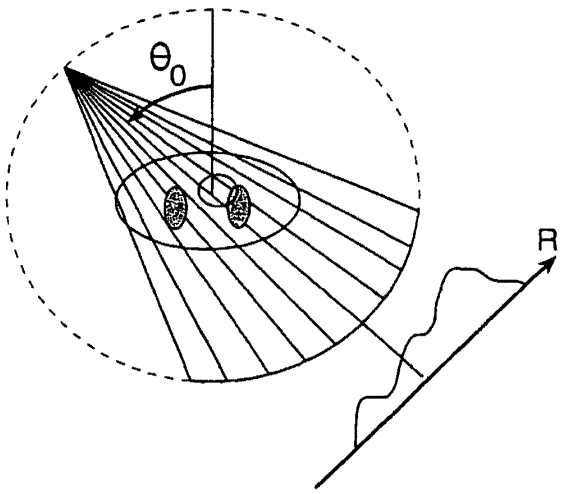
(81) Designated States *(national)*: IL, JP.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: RECONSTRUCTION OF COMPUTED TOMOGRAPHIC IMAGES USING INTERPOLATION BETWEEN PROJECTION VIEWS



(57) Abstract: An approach to image reconstruction provides enhanced image quality from limited projection data, particularly when the imaging object (or a portion of interest) is in motion during the tomographic projection data collection process. An interpolated projection view is generated from existing projection views between which an additional relationship exists by virtue of being respectively based on data collected in different data acquisition cycles. The existing projection views may represent an imaging object in consecutive data acquisition cycles or in separated data acquisition cycles or in both. The present invention provides a technique for combining the existing projection views into an interpolated projection view by interpolation in time. A further aspect of the invention provides an approach for selecting a reconstruction range for projection data representing the imaged object and covering a plurality of projection ranges. The disclosed approach allows a separation measure to be determined for the projection data for each reconstruction range. The selected reconstruction range is chosen based on the separation measures. Particular advantages are thereby obtained for cardiac imaging.

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RECONSTRUCTION OF COMPUTED TOMOGRAPHIC IMAGES USING INTERPOLATION BETWEEN PROJECTION VIEWS

CROSS REFERENCE TO RELATED APPLICATIONS

This application is related to Provisional Application U.S. Serial No. 60/166,499, filed November 19, 1999 and Provisional Application U.S. Serial No. 60/197,208, filed April 19, 2000 in the U.S. Patent and Trademark Office, the contents of which are incorporated herein by reference, and the benefit of priority to which is claimed under 35 U.S.C. §119(e).

BACKGROUND OF THE INVENTION

This invention relates to generation of computed tomographic images. More particularly, the invention relates to reconstruction of such images through use of interpolated projection views generated by interpolating between existing projection views.

Computed tomography (CT) is an imaging technology in which an array of detectors generates data from energetic rays transmitted through or emitted from an imaged subject. For example, a transmission-type medical CT imaging system uses an array of x-ray detectors to detect an x-ray beam that has passed through the body of a human or animal subject. The attenuation of the beam by the subject causes the collected data, including the effects of the attenuation, to contain information about the interior structure of the subject. The detector data are processed by a computer system to generate image data representing a recognizable view of that interior structure.

CT techniques are valuable in a wide range of application areas where noninvasive and nondestructive examination of internal structures is needed. Medical applications include imaging of emissions from radioactive substances introduced into the subject (single photon emission CT, positron emission CT, etc.), as well as x-

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ray transmission CT. Non-medical applications include, for example, non-destructive testing and inspection, mineral deposit mapping (microseismic CT imaging), and three-dimensional image generation in electron microscopy.

A CT system generates a display image from data representing measurements of energetic signals transmitted through or emitted from a subject in a range of directions. This process is "tomographic" in that structural details of a subject are represented as a cross-sectional view along a given plane through the subject. The process is "computerized" because the raw detector data indirectly represent a view of the subject. Intensive data processing is required to convert the raw data into a recognizable view of the internal features of the subject.

Computer processing of the collected data is performed because the data correspond to mere projections of the subject structure along various different paths. The term "projection data" will be used herein for such CT data, irrespective of the application area in which the CT imaging procedure is used. The differences between the projection data for different paths through the imaged subject, in relation to the spatial separation of the paths, indirectly contain information about the interior structure of the object.

A CT reconstruction algorithm is applied to the projection data to generate image data that specify the image to be displayed. The image data are generated from the structure information indirectly represented by the projections. This is possible in view of the Fourier Slice Theorem, which states generally that a projection view of an imaged subject is related by Fourier transformation to the spatial structure of the subject. More specifically, and with reference to the canonical form of the Fourier Slice Theorem for parallel beam projection data, the Fourier transform of a parallel projection at a given view angle θ is equivalent to a one-dimensional "slice" of the two-dimensional Fourier transform of the imaged subject, taken at the same angle θ in the frequency domain.

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The Fourier Slice Theorem allows the image to be reconstructed by Fourier transforming the projection views, assembling the transforms into a two-dimensional Fourier transform, and applying inverse Fourier transformation to the result. Of course, in practical applications this process may be implemented by some form of filtered back-projection or (for diffracting sources) filtered back-propagation. The salient point is that the reconstruction process relies upon the projection views that are available. It is a commonplace fact that the resolution of the generated image will depend on the spacing of the projection views in θ: the more projection views that are taken, the greater the resolution of the resulting image.

This dependence in CT imaging on data resolution in θ (angular direction) is the source of a persistent problem that will be termed here the "missing projection views" problem. An insufficient number of projection views for a desired level of image resolution can arise in many situations. For example, the data for some projection views may be corrupted, or the level of desired resolution may exceed the maximum resolution possible with the given discretization in θ.

A typical solution for data corruption is to repeat the entire data acquisition process, i.e., to throw out the entire set of projection data. Further, where θ discretization has been too coarse, the simplest solution has been to collect more projection views. More data, to provide a finer level of resolution in θ, requires more intensive computation and also entails longer data acquisition cycles. In some situations, constraints imposed by the subject to be imaged, the imaging environment, or the computational resources of the reconstruction engine make denser data collection in θ (i.e., finer resolution in θ) an unattractive solution at best and frequently one that is unfeasible in practice.

The problem of missing projection views is particularly acute when the subject being imaged, or a relevant part thereof, is in motion. For example, CT x-ray imaging is currently being used for cardiac imaging to detect arterial calcification, which can be an indicator for coronary artery disease. X-ray CT is one alternative among various non-invasive techniques for generating images of a patient's beating

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heart. Other modalities include Doppler ultrasound, fluoroscopy, magnetic resonance imaging (MRI), and electron beam tomography (EBT). Each modality has its own advantages and disadvantages for a given application context.

For cardiac imaging, x-ray CT has the potential to provide finer spatial resolution in three dimensions, as compared with MRI (especially with multi-row spiral CT). However, current third and fourth generation CT scanners suffer from coarse temporal resolution because of limited gantry speed. This limitation on temporal resolution directly affects the available spatial resolution of the resulting images of the heart. More specifically, in a data acquisition session of practicable length, each phase or distinct configuration of the beating heart will correspond to a few projection views. For any given phase, therefore, the θ discretization will be unduly coarse and will limit the resolution of the resulting image to an unacceptably coarse level.

Recent developments in image reconstruction algorithms have improved this situation somewhat by enabling CT techniques to achieve much better time resolution than with the standard operation mode. The basic approach of these improved techniques has been to use consistent projection data, collected from multiple heart cycles, and to perform retrospective data rebinning. Such data rebinning methods have been shown to improve significantly the time resolution of the collected data. In practice, however, existing rebinning methods have been found to introduce some image artifacts due to inconsistencies in the data.

It is therefore apparent that the problem of missing projection views, in cardiac imaging and in other applications of CT imaging techniques, has remained as a persistent obstacle to wider use of CT imaging. In the particular context of cardiac imaging, physicians desire a "freeze frame" capability for medical imaging systems. Such a capability would permit an image to be accurately reconstructed to represent the patient's heart at a selected part of the cardiac pumping cycle.

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More generally, what has been needed is a method and system for processing CT projection data to overcome or minimize the effects of missing projection views. Such a method desirably would provide acceptable spatial resolution in the resulting images, without requiring extensive additional data acquisition. In imaging contexts where the imaged object is in motion, such as in cardiac imaging, the method would desirably overcome the artifact problems that have existed with current data rebinning methods. Preferably, the technique would be flexibly applicable in a broad range of CT imaging contexts.

BRIEF SUMMARY OF THE INVENTION

The present invention provides methods, apparatus, software, and systems for generating additional projection views based on existing projection data and indirect relationships between the existing data. For example, such indirect relationships may exist in timing relationships between an imaged subject in a desired state and projection data representing the imaged subject in nearby states.

In a first particular aspect, the present invention provides a tomographic image generation method, and a corresponding apparatus, system and software. An exemplary implementation of this aspect of the invention is a method comprising determining a plurality of working projection views of an object at a selected view angle based on initial projection data collected in respective different data acquisition cycles. The exemplary method further comprises interpolating between the working projection views to generate an interpolated projection view of the object at the selected view angle.

In a second aspect, the present invention may be directed toward methods, apparatus, systems, and software for generating a tomographic image of an object in cyclical motion. An exemplary method of this second aspect comprises determining a plurality of working projection views of an object in cyclical motion based on initial projection data collected from the object. The working projection views are based on selected initial projection data collected in respective different

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data acquisition cycles. The exemplary method further comprises interpolating between the working projection views to generate an interpolated projection view representing the object at the selected view angle and at a specified phase of the cyclical motion.

In a third aspect, the present invention provides a method, apparatus, and software for tomographic image generation. An exemplary method of this third aspect of the invention may comprise determining separation measures for projection data covering corresponding reconstruction ranges and representing an imaged object over plural data acquisition cycles. Such an exemplary method further comprises reconstructing a tomographic image of the object based on a portion of the projection data covering a reconstruction range selected responsive to a determination that the corresponding separation measure satisfies a predetermined selection criterion.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects and advantages of the invention will become apparent and more readily appreciated from the following detailed description of the preferred embodiments, taken in conjunction with the accompanying drawings of which:

FIG. 1 is a block diagram of a general x-ray CT scanning system in which the present invention may be implemented;

FIG. 2 is a diagram of a third generation source detector assembly for a CT scanning system as shown in FIG. 1;

FIG. 3 is a diagram of a fourth generation source detector assembly for such a CT scanning system;

FIG. 4 is a diagram illustrating the correspondence between a particular view angle and generation of a row of projection data;

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FIG. 5 is an illustration of a sinogram of projection data including the row of projection data of FIG. 4;

FIG. 6 is a diagram illustrating a time dependent feature of sinogram data;

FIG. 7 is a schematic diagram illustrating a sector approach for rebinning data in cardiac imaging applications;

FIG. 8 is a diagram depicting a different perspective of the time dependent characteristics of sinogram data as provided by the invention;

FIG. 9 illustrates contrasting features of the sector approach of FIG. 7 and the perspective provided by FIG. 8;

FIG. 10 is a flow diagram illustrating a procedure of the invention;

FIG. 11 is a timing diagram illustrating a tagging function for correlation of projection data with corresponding phases of an imaged subject's cardiac cycle;

FIGS. 12-13 are diagrams illustrating an application of the present invention in cardiac imaging;

FIGS. 14-16 are flow diagrams illustrating procedures for carrying out operations as illustrated in FIGS. 12-13;

FIGS. 17-19 are diagrams illustrating an application of the present invention in a case of irregular heartbeat;

FIG. 20 is a trajectory diagram illustrating another embodiment of the invention for phase interpolation between several projection views;

FIG. 21 is a diagram of a source-detector assembly for a helical x-ray CT scanning system using a multi-row detector array;

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FIG. 22 is a schematic diagram of a multi-row detector array;

FIG. 23 is a time evolution diagram of detector row positions of a multi-row detector in helical scanning;

FIG. 24 is a graph illustrating tagging for rows of a multiple-row detector array;

FIG. 25 is a flow diagram illustrating a procedure of an embodiment of the present invention as applied in multi-row helical scanning for cardiac imaging;

FIG. 26 is a flow diagram illustrating details of an operation for selecting neighboring scanning rotations as shown in FIG. 25;

FIGS. 27-28 are diagrams illustrating operations of the procedure shown in FIG. 26;

FIG. 29 is a flow diagram illustration details of an operation for determining working projection views as shown in FIG. 25;

FIG. 30 is a diagram illustrating application of the procedure of FIG. 29;

FIG. 31 is a flow diagram illustrating a procedure of another aspect of the present invention as applied to the particular context of multiple-row helical scanning for cardiac imaging;

FIG. 32 is a flow diagram illustrating a procedure for determining a set of projection views for a selected axial position;

FIG. 33 is a trajectory diagram illustrating multiple reconstruction ranges in a set of projection views for a selected axial position;

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FIG. 34 is a flow diagram illustrating a procedure for selection of a particular reconstruction range in which to perform phase interpolation between projection views;

FIG. 35 is a flow diagram illustrating phase interpolation between projection views for view angles in a selected reconstruction range; and

FIG. 36 is a flow diagram illustrating a procedure for generating a set of tomographic slice images using phase interpolation between projection views.

DETAILED DESCRIPTION OF THE INVENTION

The present invention implements a different perspective on CT projection data, whereby a broader range of information contained in the data is recognized and used. Previous approaches to processing projection data, such as the aforementioned data rebinning techniques, have used data substitution to overcome partially the problems caused by missing projection views. In other contexts, interpolation methods have been applied to projection data to accommodate changes in the sampling grid.

However, previous methods for processing projection data have failed to recognize that distinct projection views from the same data acquisition session may contain additional information that can enhance image resolution. Such additional information may be contained in the differences between the corresponding projection data values of the respective projection views. The present invention embodies the realization that selective combination of different projection views can extract this additional information for use in improving the resolution of the generated images.

In a preferred embodiment, the present invention provides an improved processing method that achieves the objectives of previous data rebinning approaches for CT projection data collected from multiple cardiac cycles, while avoiding many of the image artifacts that have accompanied such previous approaches. The result of

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the invention is improved image quality and reduced artifacts for reconstructed images at arbitrary heart phases.

FIG. 1 is a schematic illustration showing the major components of an x-ray CT imaging system 100 in which the present invention may be embodied or incorporated. A subject 102 for imaging is typically a human patient who may be undergoing diagnostic assessment for coronary artery disease or other disease processes. Alternatively, the subject 102 may be a veterinary patient (i.e., a non-human animal) or even a non-animal subject such as an inanimate object (machine part, material sample, etc.) undergoing nondestructive testing or evaluation.

As is well known, x-ray tomographic imaging with such an imaging system 100 is typically carried out by illuminating the subject 102 with an x-ray beam 104 substantially transverse to an axis (shown by cross-hairs) through the subject 102. Typically the axis is centered on an object 106 of interest, such as an organ or other tissue structure. The subject 102 may be disposed on a table 108 that translates along the direction of the axis, thereby enabling illumination of a volumetric portion of the subject 102 by the x-ray beam 104. In the typical case the illuminated volumetric portion comprises all or a relevant portion of the object 106 of interest within the subject 102.

The CT system 100 desirably comprises a source-detector assembly 110, which in an exemplary embodiment may comprise a gantry 112 rotatable about the axis. An X-ray source 114, such as a typical X-ray tube, may be mounted on the gantry 112 and may rotate with rotation of the gantry 112. Source 114, which may comprise a collimating element (not shown), projects the beam 104 of x-rays toward a detector array 116 disposed opposite the source 114 relative to the gantry 112.

The detector array 116 is typically comprised of numerous individual detector elements 118. An alternative term in the art for an array such as detector array 118 is "a multi-channel detector." It will be understood that either term is

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intended to mean a multiple-channel detection device usable in a computed tomography system.

Detector elements 118 together provide information regarding the internal structures of the subject 102, such as the object 106. As noted above, the subject 102 may be a human patient or an animal patient. In either of these cases, the object 106 may be an organ or body part of the subject 102 and thus is the "object" for purposes of the tomographic image. In a still further alternative application, the subject 102 may itself be the object 106 being subjected to, for example, nondestructive testing or examination.

In the typical case, each detector element 118 generates an electrical signal indicating the intensity of a portion of the x-ray beam 104 impinging thereupon. Various alternatives for the specific arrangement of the source-detector assembly 110 will be described with reference to FIGS. 2-3 and 21.

The signals from detector elements 118 may indicate a degree of attenuation of the beam 104 as the x-rays traverse the material or substance of the subject 102. Typically the source 114 is rotated around the subject 102 to execute a so-called "scan" operation whereby the system 100 acquires x-ray data. The gantry 112, with source 114 attached to a side portion thereof, typically rotates about the axis of the subject 102 to acquire x-ray data from numerous different illumination angles or "view angles."

The rotation operation for the source 114 is controlled by a control/interface system 120. A controls section 122 of the control/interface system 120 provides control for positioning of the gantry 112 relative to the subject 102, such as controlling speed of rotation about the axis and control of relative positions of the table 108 and the gantry 112. The controls section 122 also typically provides control over x-ray generation (power and timing) of the source 114. The control/interface system 120 also includes a data acquisition system (DAS) 124 that samples the

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detector signals generated from the detector elements 120 and converts the sampled signals into digital data for further processing.

A reconstruction engine 130 receives the sampled and digitized data (now termed "projection data") from the DAS 1124 and performs high-speed image reconstruction. The reconstruction engine 130 may comprise a separate processor 132 and memory 134. Various algorithms are known in the art for reconstructing a slice image from projection data comprising a plurality of projection views.

The reconstruction engine 130 sends the reconstructed image to, for example, a system management computer 140 for storage, display, or further processing. The computer 140 typically comprises a CPU (a processor) 142 and a memory 144. The memory 144 may store a program 146 comprising instructions for executing a process of the present invention. Alternatively, such a program 146 may be executed (in whole or in part) by the reconstruction engine 130 or by another computer system (not shown) comprised in or coupled to the imaging system 100.

The computer 140 may display the reconstructed image on a display 152 in response to instructions from an operator console 154. Computer 140 may also convey commands and scanning parameters from the operator console 154 to the control/interface section 120. Alternatively, the image may be output to a recording device 156, such as a film recorder, or stored in a mass storage device 158. Alternatively, the image may be transmitted as image data over a network (not shown) for disposition at another location. If the computer 140 stores the image in the storage 158, the image data may be stored as a data array, a linked list, or any other known data storage configurations as are well known in the art.

An aspect of the present invention provides a tomographic imaging system with the capability to generate accurate tomographic images of an object in motion. Such an imaging system may therefore comprise a system or apparatus for acquiring timing data by which the projection data collected by the system may be correlated in time with the motion of the imaged object. For example, the system 100

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may be used to generate tomographic images of a patient's heart while the heart is beating. A timing data acquisition system for the imaging system 100 may therefore comprise an electrocardiogram such as an EKG unit 160 shown in FIG. 1. The EKG unit 160 detects electrical activity of the patient's heart and provides to the computer 140 timing information based on the detected electrical activity. For example, the timing information may be digital electrocardiographic data. The construction and use of electrocardiograms is well known to those of skill in the art and will not be presented in detail here.

The different functions of control/interface system 120, reconstruction engine 130, and computer 140 are desirably implemented on dedicated modular platforms, as described. However, the division of functions described herein is for purposes of example and is not intended to be limiting. Such functions may alternatively be implemented in software, on a single computational platform, or in a different arrangement on multiple hardware platforms.

FIG. 2 illustrates a source-detector assembly 200 as a specific embodiment of the source-detector assembly 110 shown schematically in FIG. 1. An imaging subject 202 corresponds to the subject 102 in FIG. 1. Assembly 200 illustrates the particular case of a so-called third generation "fan beam" CT system in which the subject 202 is illuminated by a beam 204 while positioned on a motorized table 208. The beam 204 may be a "fan beam," as described below.

A gantry assembly 212 corresponds to the gantry 112 of FIG. 1. An x-ray source 214 generates the fan beam 204 of x-rays directed toward a detector array 216, which is also affixed to the gantry assembly 212. Array 216 comprises individual detector elements 218 that detect x-rays emitted by source 214. The array 216, source 214, gantry 212, and table 208 of the fan beam assembly 200 are respective instances of the array 116, source 114, gantry 114, and table 108 as shown in FIG. 1.

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In operation, assembly 212 rotates around the axis Z, which typically passes through subject 202 and is perpendicular to the plane XY. Source 214 can thereby be transported completely around subject 202 along a circular path. Detector array 216, being fixed with respect to source 214, is also transported around subject 202 and thus remains opposite source 214.

Rotation of the gantry assembly 212 around the subject 202 results in x-ray data being generated by detector elements 218 for a range of view angles θ. A typical detector array 212 may comprise several hundred, such as 888, individual detector elements 218. The array 216 may be positioned on the gantry 212 at a distance of, for example, 0.949 meter (m) from the source 214. The circular path of source 214 has a radius of, for example, 0.541 m. Particular values of these parameters are not critical to the present invention and may be varied according to well-known principles of CT system design.

One complete gantry rotation for the gantry 212 may comprise, for example, 984 increments. Source 214 is thereby positioned to illuminate the subject 202 successively from 984 different directions θ. Detector array 216 generates x-ray data at each incremental position θ, from which projection data for 984 projection views may be generated.

FIG. 3 illustrates a source-detector assembly 300 for a so-called fourth generation CT system. A subject 308 is again illuminated by a fan beam 304 while positioned on a motorized table 308. An x-ray source 314, like source 214 and as a further example of source 114, generates the fan beam 304 of x-rays directed toward a detector array 316. The array 316 comprises detector elements 318 that generate x-ray data indicating internal structural information about the subject 302.

The fourth generation case of FIG. 3 differs from the third generation case, in that the detector array 316 is fixed with respect to rotation. The source 314 is supported by a suitable guide mechanism (not shown) and typically traverses a circular path around the subject 302. The detector array 316 may translate axially (in

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the Z direction) to provide x-ray data for a particular axial position. Alternatively, the array 316 may be fixed axially as well as rotationally, and positioning of the subject 302 with respect to the detector array 316 and source 314 may be achieved entirely by axial translation of the table 308.

As FIG. 2 shows, a typical third generation CT scanning system performs an axial CT scan by rotation of the gantry around the subject to be imaged. The detector data are collected as the gantry rotates the source and the detector array together. The projection data are thereby generated for different angular positions (i.e., view angles) of the gantry. A fourth generation system comprising an arrangement such as the assembly 300, shown in FIG. 3, differs in that the detector array is usually stationary (at least rotationally) with respect to the subject. The source then traverses a path around the subject and thereby projects imaging rays at different angles for detection by different portions of the fixed array.

On the other hand, both the assembly 300 and the assembly 200 may use a fan beam (204 or 304). A "fan beam" is a fan shaped beam of radiation, i.e., a beam subtending a finite angular sector in a given plane. Usually the fan is thin, where "thin" refers to the direction transverse to the fan plane, e.g., a direction generally parallel to the axis Z. X-rays in the angular sector actually subtended by the fan beam may not all be used for generation of detector data. Thus, an effective portion of the fan beam may subtend a smaller angular sector whose angular extent is called the "fan angle" of the fan beam. In the arrangements of FIGS. 2 and 3, the plane of the fan beam is transverse (typically perpendicular) to the axis Z at a fixed axial position.

A rotational scanning operation performed at a fixed axial position is sometimes called an "axial scan." The axial scan is carried out with rotation of the source (or the source and detector together) about the subject at a fixed axial position z0. Therefore, the projection data from an axial scan all represent the imaged subject at the same axial position z_0.

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The present invention provides an approach for enhancing resolution and image quality of a CT image without requiring additional detectors or additional data acquisition and generally may be applied to axial CT systems (e.g., third generation and fourth generation systems). The invention may also be used with less advanced (e.g., first or second generation) source-detector arrangements. Moreover, as will be explained below, the invention may be embodied in or implemented with spiral (i.e., helical) CT imaging systems. The basic features of the invention will be explained first in the axial CT context and then extended, with appropriate enhancements, to the helical case.

It is noted that similar operations of rotation apply in both third generation and fourth generation systems for the acquisition of detector data during a complete cycle of the source-detector assembly. In the axial scanning case, the data acquisition cycle is called an axial scan. More generally, the principle of a rotational cycle of data acquisition is generally applicable in all such x-ray CT scanning systems. The term "scanning rotation" will therefore be used here to mean the rotational operation for positioning the x-ray source (e.g., source 214 or source 314) at each angular position θ around an axis of rotation and collecting corresponding data. "Scanning rotation set" will mean the set of projection data generated from a scanning rotation. Where no confusion will arise, the term "scanning rotation" will be used variously to mean either the data acquisition operation or the projection data set generated as a result of the data acquisition operation.

Typical x-ray CT systems (e.g., third generation systems and fourth generation systems) are an exemplary class of tomographic imaging systems. For example, magnetic resonance imaging (MRI) systems also are used to generate tomographic images by a data collection and image reconstruction process that may be termed (in a generalized sense) computed tomography.

Cardiac imaging can be performed with some MRI systems by processing a series of magnetic echo data sequences with various types of gating techniques. In prospective spin echo gating, for example, the system acquires

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imaging data over a series of cardiac cycles. An additional sequence of spin echo data is acquired at each cycle. Each spin echo data sequence represents the heart at different spatial locations but is acquired during the same cardiac cycle and with the same k-space encoding value. Thus, the data collection operation for acquiring such a spin echo data sequence is analogous to the scanning rotation operation in x-ray tomographic imaging. In each case, the operation is a data sampling cycle for acquiring a consecutive sequence of data samples over a cycle interval.

Also, retrospective gating of gradient echo pulse sequences is used in MR systems to acquire "cine" images at multiple time frames of the cardiac cycle. Data acquisition again occurs over several cardiac cycles, and in each acquisition cycle the data samples have the same phase (i.e., k-space) encoding value. The phase encoding value is thus stepped to a next value at each successive R-wave trigger. The excitation pulses run asynchronously with the cardiac cycle, so that the echo pulse data acquired in each sampling cycle is resorted and interpolated into evenly distributed time frames within the cardiac cycle. Nevertheless, like rotational scanning in x-ray systems, the sample data are again acquired in a series of sequences of data samples acquired consecutively over a sampling cycle interval.

These examples illustrate a general principle of data acquisition in tomographic imaging systems: the imaging data are acquired in one or more sequences of data samples. Here, the term "data acquisition cycle" will mean a data acquisition operation for obtaining such a sequence of data samples at a sequence of consecutive sampling times. Thus, in existing approaches to x-ray tomography the data acquisition cycle is the scanning rotation (which may be carried out by gantry rotation or source rotation, for example). For MRI systems, the data acquisition cycle may be the sequence of measurement operations in which the magnetic field gradients are varied according to the particular localization method being used. As will be explained in detail, the present invention adopts a different perspective on combining data from different data acquisition cycles.

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Data from an axial scan may be stored in a two dimensional array called a "sinogram." One dimension of the sinogram corresponds to angular position of the fan beam (e.g., scanning rotation angle or "view angle"), relative to the initial rotational orientation of the beam at the start of the data acquisition cycle. The other dimension corresponds to positions of the detector elements (218 or 318) of the detector array. The detector array in a fan beam CT system (such as array 216 or array 316) typically comprises a single row of detector elements. In such a case, therefore, each row of the sinogram will correspond to a discrete view angle θ and a single axial position z0.

In the fan beam case, the sinogram may be considered as a collection of projection views of the subject at the position z_0. Here the term "projection view" means such a row of projection data corresponding to a given view angle θ and representing the imaged subject at a single axial position z_0. Well known reconstruction procedures utilize as their principal inputs a complete set of such projection views (discretized in θ, but all consisting of data values for the same axial position z_0). The projection views are processed to generate a slice image depicting the internal features of the subject at the position z_0. Usually the complete set of projection views comprises projection views at view angles covering at least radians (i.e., 180 degrees) plus the fan angle.

FIG. 4 illustrates the correspondence between a particular view angle θ_0 for the source and the generation of a well-defined row R of projection data. In the fan beam case, as noted above, the detector data from the detector array may convert directly into a single row of projection data for a projection view at view angle θ_0. This correspondence results because the detector array provides a single row of detector data representing intensities of the x-rays impinging upon the detector elements. These intensity values indicate attenuation information for the subject at the axial position z_0.

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FIG. 5 shows how the projection data for the particular view angle θ_0 is stored in a corresponding row of the sinogram. Each row of the sinogram thus constitutes a projection view that indicates attenuation information for a distinct view angle θ, but the same axial position z_0. Once the sinogram is filled with projection views (rows) for all the discrete view angles θ around the subject, then a suitable CT image reconstruction algorithm is applied to reconstruct a cross-sectional image of the subject.

FIG. 6 illustrates a time dependent feature of the projection data stored in the sinogram. The view angle θ of the source relative to a fixed direction can be written as

$$\theta(t) = \omega t,$$

where ω represents the angular speed of the gantry in radians per second and t denotes time. Each row R of the sinogram therefore represents information about the subject (at the axial position z_0) at a different time t.

Usually the fact that the rows of the sinogram are time dependent is inconsequential, because the subject is immobile during the scanning process. The assumption of stasis may be reasonable even for a living patient, because the patient can be well constrained during the time it takes to collect all the projection views (0.5 – 0.8 seconds). For example, when the area of interest is the patient's head, abdomen, etc., the body part of interest can be assumed to be stationary during the scan.

However, in cardiac imaging the assumption of stasis clearly does not apply, at least for a living subject. The beating of the patient's heart persists and cannot be suspended. Moreover, a heart rate of 72 beats per minute (bpm), for example, corresponds to 0.83 seconds (s) per beat. The heart thus completes a full cardiac cycle in a time span comparable to the time required for collecting projection views at all the view angles θ. The beating heart thus undergoes a substantial portion

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of a complete cardiac cycle while the projection data for a slice image are being obtained.

The particular motion that affects cardiac CT imaging is largely the cyclical change in the shape of the heart throughout the cardiac cycle. However, the same imaging problem appears in various situations where the object of interest is in motion during the CT scan process (the data acquisition cycle). The scanner is unable to generate a clear image of the object being imaged at a particular position (e.g., a particular phase of the cardiac cycle) because the object moves too rapidly for a complete set of projection data to be collected while the subject is in the desired position or configuration.

The problem may be analogized to the problem in conventional photography of freezing a subject in motion. If the camera shutter speed is too slow, the subject will undergo a significant amount of motion while the shutter is open (i.e., collecting image data). The resulting image of the subject is blurred. In a like manner, the CT scanning system may be unable to generate a clear slice image, if the subject is in motion while the scan data are being collected. In effect, the CT scanner has a slow shutter speed relative to most rates of motion of the subject.

FIG. 6 thus emphasizes that the collection of projection data proceeds as a function of time while the gantry or source is rotating. A projection data set should be complete (covering as much as 360°, but at least 180° plus the fan angle) to provide a useable tomographic image upon reconstruction. However, if the projection data set consists of projection views from a single scanning rotation, the projection views will respectively represent the heart at many different phases of the cardiac cycle. Each projection view corresponds to a particular row in the sinogram, but is collected at a different moment in time. Strictly speaking, reconstruction of an image at any particular phase of the heart requires collecting all the projection views (all rows of the sinogram) at that particular instant in time. This would require a very fast data acquisition cycle (i.e., a very fast shutter speed for the CT scanning system).

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A feasible solution to this problem can be achieved by making use of the cyclical nature of the cardiac cycle (more generally, any repeating feature of the motion of the object of interest). As the cycle repeats, the beating heart moves through the same cycle of shapes and assumes successive shapes in an ordered sequence in time. Multiple scanning rotations, together with data gating, can be used to collect several projection views corresponding to the same phase from multiple heart cycles. The CT scanning system can thereby generate the projection views to be used in reconstructing an image of the beating heart at a particular heart phase.

Unfortunately, obtaining all the desired projection data directly through respective data acquisition cycles would entail an inordinately large number of scanning rotations for the corresponding projection views. The "shutter speed" problem arises here in a different form: although the heart regularly repeats the cardiac cycle, the subject being imaged otherwise desirably remains stationary throughout the data collection process. A reasonable number of scanning rotations, during which the subject can be expected to remain generally stationary, will provide just a few projection views of the heart at a given phase.

FIG. 7 illustrates this problem through a simplified example in which three projection views are collected at the desired heart phase, $t=\phi_0$. It is noted that phase ϕ is measured in units equivalent to time t. Here a distinct symbol (ϕ) is used for phase to emphasize the periodicity of the heart motion, because periodicity is a dynamical feature not present in dynamic phenomena generally. The three views correspond sequentially to heart cycles 3, 1, and 2 as shown and may be collected in, for example, three scanning rotations. At 0.5 s per scanning rotation, even this level of data collection requires the patient (the imaged subject) to remain stationary for at least 1.5 s.

The following scheme has been partially successful in overcoming the persistent problem of missing projection views in the context of cardiac imaging. An assumption is made that, at least for some phases to of the cardiac cycle, the heart motion may be relatively slight in the neighborhood of $t= \phi_0$. As FIG. 7 shows, the

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heart cycle is divided into a few phase sectors, in each (or at least some) of which the heart is assumed to be close to stationary.

For each scanning rotation of the CT system, the phase sectors of the cardiac cycle can be associated with angular sectors of the rotation. Data for projection views at many different view angles are collected in each scanning rotation. If the foregoing assumptions are valid, then from all the scanning rotations the data corresponding to the phase sector of the desired phase can be used for reconstruction of an image of the heart at the desired to phase.

The approach described above has been termed data "sectoring" or "data segmentation" and has been implemented successfully in various contexts. For example, U.S. Patent No. 5,997,883, issued December 7, 1999, to Epstein et al. and assigned to the assignee of the present application, discloses a cardiac imaging technique using segmented MRI cardiac data. Data segmentation has been shown to yield x-ray CT images with image quality satisfactory for many purposes. On the other hand, such CT images suffer from certain noticeable artifacts, such as streaks. The artifacts in these images are believed to be due to inconsistency of the projection data, particularly in the regions of transition between the different sectors, because the different projection views actually represent the heart at somewhat different cardiac phases..

FIGS. 8-9 illustrate analysis of sinogram data through a different perspective that constitutes an aspect of the present invention. The diagonal trajectories 1, 2, and 3 in FIG. 8 illustrate the time dependence of the sinogram data, as shown previously in FIG. 6. Thus, each trajectory (1, 2, or 3) represents a sequence of sinogram rows as θ evolves in time. FIGS. 8-9 depict the trajectories as continuous diagonal lines, for purposes of illustration. However, like the sinograms they represent, these trajectories actually represent the sinogram data as comprising projection views corresponding to a discrete sequence of view angles θ.

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If the period of the cardiac cycle and the period of the data acquisition cycle are different, projection views can be collected corresponding to different phases of the heart during each rotation. Here T_{gantry} and T_{heart} correspond to scanning rotation period and cardiac cycle period, respectively. For description purposes, the particular example of FIG. 8 illustrates the case where T_{gantry} is less than T_{heart}. However, and the present invention readily applies also to the case T_{gantry} greater than T_{heart}.

The data trajectories are indicated in FIG. 8 by diagonal lines with arrows and represent the projection data in the θ-t domain. It is noted that θ=0° and θ=360° actually represent the same angular position. Hence each trajectory in FIG. 8 wraps around to 0° whenever θ reaches 360°. Further, because $T_{gantry} < T_{heart}$ in the case illustrated, the ordinal extent of the domain is [0, T_{heart}), and each trajectory wraps back to t=0 whenever the trajectory reaches t=T_{heart}. Each recurrence of t=0 corresponds to a next cardiac cycle, which is represented in FIG. 8 by another trajectory.

The scheme described above assigns projection data for a given view angle θ from the trajectory nearest to the vertical line at $t=\phi_0$. As noted above, this approach is commonly known as data sectoring or data segmentation. However, in view of the perspective provided by FIG. 8, a more descriptive term may be "nearest neighborhood substitution." The idea is to substitute data from the desired view, but from a nearby phase, in place of the missing projection view for the desired phase.

FIG. 9 illustrates the relationship between the data sectoring approach and the perspective illustrated in FIG. 8. The range of cardiac phases is "segmented," or divided into segments (or "sectors") denoted I, II, and III. The sectors correspond to predetermined portions of the cardiac cycle. In each of the trajectories 1, 2, and 3, the phase sectors correspond to respective angular regions in θ. Hence each of the trajectories 1, 2, and 3 is divided into angular segments corresponding to the phase sectors I, II, and III. FIG. 9 also shows that the phase sector (sector I) of the phase to coincides with different angular segments for the different trajectories. As noted

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above, the sectoring approach assigns substitute projection data for missing projection views according to the phase sector of the phase to at the desired view angle θ_m.

For example, the view angle θ_m in FIG. 9 corresponds to a missing projection view 900 for the phase ϕ_b, because none of the trajectories 1, 2, and 3 pass through the point (in θ and t) at which the view 900 is desired. The sector approach determines the trajectories within the phase sector of the target phase at the desired view angle and identifies an available projection view at that view angle and on the trajectory nearest in time to the phase to.

In FIG. 9, the projection view 910 is the projection view nearest to the desired phase. The projection data for this nearest neighbor projection view are then substituted for the missing projection view. It is noted that the information associated with other projection views, such as the next nearest projection view 920 in FIG. 9, is completely ignored in the sector approach.

The present invention uses a different perspective of the projection data and of the problem of missing projection views. For a scan where the gantry is continuously rotated, the trajectories in FIG. 8 represent the data collected in the two dimensional domain of view angle versus time (θ vs. t). This perspective enables the invention to take a different approach for processing the projection data. Instead of block assignment of the data to different phase sectors, the present invention makes use of additional information revealed by representing the projection data as trajectories. In fact, the trajectories allow quantitative relationships between the available data and the desired data to be discovered and utilized.

The perspective adopted by the invention enables the additional information contained in an additional projection view, such as the second projection view 920 in FIG. 9, to be incorporated into projection data for the missing projection view. This incorporation of multiple working projection views into projection data for a missing projection view is achieved through interpolation in the sinogram phase domain, i.e., along the t axis. For a set of (two or more) existing projection views at a

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given view angle, corresponding data values of the projection views are interpolated to generate a corresponding data value for an interpolated projection view at the given view angle and the desired phase. Here, therefore, interpolation between projection views means to carry out the same relative combination of data values for all the row positions of the set of projection views being interpolated.

FIG. 10 shows a flow diagram illustrating an interpolation procedure 1000 of the invention. An operation 1010 determines the initial projection data available. This initial data may comprise, for example, sinograms of projection data providing plural trajectories of projection views accumulated over time, as illustrated in FIG. 8. Such initial projection data may be generated directly by a DAS such as DAS 124 in FIG. 1. Alternatively, as explained below, the initial projection data may be determined from the digitized detector data by rebinning or other preprocessing operations, as are well known in the art.

An operation 1020 selects a view angle for which a projection view is to be synthesized through interpolation. From existing projection views of the initial projection data at the selected view angle, working projection views are determined in an operation 1030. The working projection views will represent the imaged object at the selected view angle, but in different data acquisition cycles. For example, in a particular embodiment of the invention, the interpolation may be performed between two projection views such as views 910 and 920 shown in FIG. 9. In such a particular instance, then, the working projection views are determined as the two projection views that are nearest in time to the desired phase ϕ_0, among projection views at the desired view angle in the initial projection data.

Interpolation is performed between the corresponding data values of the working projection views in an operation 1040. Any of various different interpolation techniques may be employed for this purpose, as are well known to those of skill in the art. For example, weighted linear interpolation between neighboring data trajectories is a particular interpolation method that has been used effectively. The weights may be computed based on respective timing differences

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between timings of the selected working projection views and a corresponding timing of the desired projection view. For example, in an implementation of the invention for cardiac imaging, the timings of the working projection views and the desired projection views may be embodied in corresponding phases of the cardiac cycle.

Where the initial projection data comprise data sinograms for cardiac imaging, the sinograms are preferably correlated with simultaneously collected timing data such as electrocardiogram (EKG) data generated by the EKG unit 160 of FIG. 1. The correlation provides a time stamp for each row of detector data. The time stamp of a row of projection data provides an explicit cross reference between the row of data and the shape configuration of the heart (as determined by the EKG data) at the time the row of data was collected.

FIG. 11 illustrates an approach for using such time stamps to correlate the projection data with contemporaneous electrocardiographic data. The EKG data represent an electrocardiograph 1110 of the patient's heart during the tomographic scanning procedure. The projection data represent the heart at various phases of the cardiac cycle and are collected at a known sampling frequency (e.g., 984 projection views in each period of the gantry rotation) that allows the projection views to be time stamped with respective temporal locations.

On the other hand, the projection data do not contain explicit phase information. The contemporaneously collected EKG waveform 1110 can be used to determine such phase information, provided the collection of the EKG data is synchronized with collection of the projection data. The projection data also do not explicitly comprise axial position (Z-location) information, but such position data may be recorded sequentially as each axial scan is performed.

In a particular implementation, for example, the EKG data for the waveform 1110 may be collected during the scanning procedure by the EKG unit 160 and may be digitized at a specified sampling frequency (e.g., 240 samples per second). The particular sampling frequency is not critical to the present invention.

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The criteria for selecting a suitable sampling frequency are well known to those of skill in the art, and such criteria will not be described here.

The temporal locations of the R-wave peaks of the waveform 1110 may be identified using any of various well-known waveform analysis techniques. Using the identified peak locations, a linear phase function 1120 may be defined to increase from 0.0 to 1.0 between each consecutive pair of R-wave peaks.

The function 1120 may be used to map (i.e., to correlate) the phases of the cardiac cycle to the time-stamped temporal locations of the projection views. Each projection view is thereby assigned a cardiac phase $_{ij}()$, where the indexes i and j respectively identify the cardiac cycle and gantry rotation of the scanning procedure. It is noted that the cardiac phase assignment $_{ij}$ may further be associated with specific axial positions, as will be explained below with reference to FIG. 24. The phase function 1120 (defined between all consecutive R-wave peaks of the waveform 1110) thereby allows all the projection views of the projection data to be correlated (tagged) with an associated cardiac phase $_{ij}$.

In the simplest case, it may be assumed that the heart rate is constant while the scan data are collected. The desired phase (in the case of cardiac imaging, corresponding to a shape configuration of the patient's heart) then occurs in each cardiac cycle at a fixed fraction of the heart period T_h following the preceding R-wave. This assumption of regular heartbeat simplifies the process of cross-referencing the projection data and the EKG data. In particular, for each R-R heart cycle the desired phase of the heart occurs on the vertical line ϕ_0 in FIG. 8.

An advantage of the foregoing implementation is that a phase function, such as the linear phase function 1120, allows correlation between heart phases and row data to be carried out even when the subject's heart rate is irregular. In either case, the time correlation between the EKG data and the collected scan data may be performed off-line, i.e., after the projection data is initially collected, binned, and time stamped.

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The linear phase function 1120 shown in FIG. 11 is only one example of a feasible phase mapping function for EKG data. Other, possibly non-linear phase mapping functions are also feasible for use with the present invention. Such alternative mappings may permit the electrocardiographic behavior of the R-R cycle to be modeled more accurately and in more detail. In turn, more accurate and detailed modeling of the electrical cycle of the heart may permit more accurate time correlation of the heart phases.

Adaptive Projection Data Processing

In a particular embodiment of the procedure illustrated in FIG. 10, the initial projection data may represent a patient's beating heart, and the two nearest projection views may be identified based on the time correlation between the collected projection data and the EKG data. The time stamps of the projection data allow the working projection views to be determined in operation 1030 based on the correlation between the gantry rotation and cardiac cycle. For example, the projection view 910 on trajectory 1 in FIG. 9 may be identified from the timing at which the gantry rotation coincides with the missing view angle θ_m and the assigned phases $_{ij}$. The phases $_{ij}$ of the projection views may be used with the EKG data to determine the phase differences, as will now be explained.

FIGS. 12-13 illustrate the data relationships that may be utilized in a particular embodiment of the invention. In FIG. 12, the initial trajectories 1 and 2 respectively include projection views 1210 and 1220 at the desired phase ϕ_0 and corresponding view angles. The point 900 again represents a missing projection view for the heart phase ϕ_0, because neither of the available trajectories includes a projection view at the view angle θ_m. Two nearest neighbor projection views 910 and 920 may be identified from the trajectories 1 and 2, respectively, using the time stamp correlations.

FIG. 13 shows phase differences d_1 and d_2 (represented as timing differences) respectively associated with the projection views 910 and 920. Using

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such timing differences, the data values of 910 and 920 may be combined through a predetermined interpolation process (operation 1040 of FIG. 10) such as a weighted linear interpolation process. A data value for view 900 may be determined in such a process from corresponding data values for the views 910 and 920 using an interpolation formula such as

$$P = \frac{1}{\Delta T}[d_2 P' + d_1 P''] \qquad (1)$$

$$= \left(\frac{\phi_0 - T_2}{T_1 - T_2}\right)P' + \left(\frac{T_1 - \phi_0}{T_1 - T_2}\right)P''$$

where $\Delta T = T_1 - T_2$, $d_1 = T_1 - \phi_0$, and $d_2 = \phi_0 - T_2$. Here P′ and P″ are the data values of the views 910 and 920 at respective detector positions in the projection views.

In the foregoing example the differences d_1 and d_2 may be determined directly from the time stamp data of the projection views 910 and 920, if the heart rate is assumed to be constant. Such an assumption ensures that the difference in the heart configuration at ϕ_0 and T_1, for example, directly corresponds to the time difference d_1. On the other hand, as noted above, the present invention also accommodates an irregular heart rate for which the heartbeat period T_h may vary with each trajectory.

FIG. 14 shows a flow diagram illustrating the main operations of a procedure to implement the invention for generating a projection data set comprising a complete set of projection views for reconstructing a slice image. As in the operation 1010 of FIG. 8, an operation 1410 determines the initial projection data (i.e., the sinogram data for a plurality of scanning rotations). A particular phase of the cardiac cycle, such as $t = \phi_0$, is selected in an operation 1420.

An initial view angle is selected in an operation 1430. Both the initial view angle and the angular interval between projection views typically will depend on the θ discretization (the sampling frequency, such as 240 Hz) of the sinogram data.

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An initial testing operation 1440 may determine whether the initial projection data includes a projection view for the selected view angle and the selected phase.

If the selected view angle corresponds to a missing projection view at operation 1440, then the procedure determines working projection views at operation 1450. An interpolated projection view is generated at an operation 1460. These operations will be described in detail with reference to FIGS. 15-16. If the sinogram data includes a projection view for the selected phase and view angle, then the desired view angle is not a missing view angle. The procedure of FIG. 14 then skips operations 1450-1460 and advances to an operation 1470, where a determination is made as to whether the selected view angle is the last view angle needed for the desired reconstruction. If not, then a next view angle is selected at operation 1480, and the procedure returns to the testing operation 1440.

FIG. 15 shows a flow diagram illustrating a version of the determination operation 1450. In an operation 1510, a projection view for the selected view angle is selected from the initial projection data. The particular projection view may be selected based on both the selected view angle and the initial projection data corresponding to phases prior to the selected phase ϕ_0 in the cardiac R-R cycle.

As has been noted with respect to FIGS. 12-13, the selected view angle occurs in each of the data trajectories of the initial projection data at a specific timing. A preferred embodiment of the invention in this aspect selects the projection view 920 at the selected view angle and occurring in the trajectory 2 closest in time before the timing of the desired cardiac phase ϕ_0. The term "configuration phase" will be used to mean the phase of the physical configuration of the heart at an associated moment in each beat of the heart.

An operation 1520 produces a similar selection result, but the projection view 910 is selected from projection data subsequent to the selected phase (time). These two operations (1510 and 1520) determine two projection views that

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may be used as the working projection views in the remainder of the procedure illustrated in FIG. 14.

FIG. 15 illustrates a particular embodiment for selecting working projection views in pairs. It will be apparent to those of skill in the art that the present invention also encompasses other arrangements for selecting the working projection views. Indeed, a significant aspect of the present invention is the discovery that substantive relationships can exist between disparate initial projection views. Such relationships can provide additional information for improving the quality of reconstructed images. Thus, as will be seen, the present invention encompasses a variety of different approaches for identifying initial projection views between which such substantive relationships exist. Various embodiments of the invention are possible for combining the initial projection views to utilize the additional information that may be provided by relationships.

FIG. 16 is a flow diagram illustrating a particular embodiment of the interpolation operation 1460 of FIG. 14. As FIGS. 4-5 indicate, each projection view may comprise, for example, 888 data values each corresponding to an output of a detector element of the detector array (such as array 216 or 316). An operation 1610 selects respective initial data elements from the working projection views. This selection may be based on the position of the detector element from which the data elements are generated. Alternatively, any other commensurate numbering system for identifying the respective data elements in the sinogram rows may be used.

An operation 1620 performs a computational procedure to interpolate between the selected data element values of the working projection views. Any of various interpolation procedures may be used, as discussed below. The result is an interpolated data value corresponding to the selected data element position, the selected phase, and the selected view angle. An operation 1630 determines whether further sets of data elements remain to be interpolated between the working projection views. If so, then the next data element values are selected at an operation 1640 (such

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as by selecting a next detector element position). The procedure of FIG. 16 then returns to the operation 1620 for another iteration of the interpolation computation.

The approach of the present invention makes the resulting projection data (any initial projection data for the desired phase, in combination with interpolated projection data) more consistent, particularly at view angles near angles at which the sector approach would join different sectors. The results provided by the invention are further improved by the fact that the general profile of motion during the cardiac cycle is known as a function of time. This profile can be used to compute weights to be used in the interpolation operation 1460. In particular, it has been found that careful selection of the interpolation weights based on the motion profile can result in even better image quality.

In a particular implementation of the invention, the weights may be selected to minimize image distortion arising from motion of the heart at the working projection views. In this approach the interpolation method weights the data from a particular working projection view (and trajectory) based on the amount of heart motion at the phase of the cardiac cycle to which the working projection view corresponds. The weighting applied to the other trajectory (or trajectories) used in the interpolation may be changed similarly, based on the relative heart position (or configuration) at the respective phases.

The relative heart position at a given projection view may be determined through off-line analysis of the contemporaneous EKG data. The amounts of heart motion at different configuration phases are well known to those of skill in the art of cardiac physiology and may be correlated to the projection views P′ and P″ through the EKG data.

Alternatively, any of various other interpolation methods may be used. In another particular implementation, a weighted inverse quadratic interpolation is performed. Here each weight may be computed to be proportional to the square of the time difference between the interpolated time and the time of the weighted

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projection data value. For example, a data value for the projection view 900 may be computed according to the formula

$$P = \frac{1}{d_1^2+d_2^2}[d_2^2 P' + d_1^2 P''] \quad (2)$$

$$P = \frac{(\phi_0 - T_2)^2}{d_1^2+d_2^2} P' + \frac{(T_1-\phi_0)^2}{d_1^2+d_2^2} P''$$

$$P = \frac{(\phi_0 - T_2)^2}{(T_1-\phi_0)^2+(\phi_0-T_2)^2} P' + \frac{(T_1-\phi_0)^2}{(T_1-\phi_0)^2+(\phi_0-T_2)^2} P''$$

It is noted that the equations (1) and (2) illustrate this feature of the present embodiment in the simple case where $|T_1-\phi_0|$ and $|\phi_0-T_2|$ are less than $T_h/2$. In many cases this condition may be satisfied automatically by using existing projection views 910 and 920 from consecutive gantry rotations (consecutive data acquisition cycles). However, the present aspect of the invention also applies in many other contexts where one or more of these simplifying assumptions fails to hold. The principles of the present aspect of the invention may also be applied where a direct phase difference (such as $T_1-\phi_0$) actually is greater than $T_h/2$. Such a case may be addressed as described with reference to equation (5) below.

Among its numerous advantages, the present invention enables the times at which to collect the projection data (for reconstructing an image of the heart at a particular configuration phase) to be determined prospectively. A method of the present invention therefore does not require the X-ray tube to be on all the time. Instead, a method of the invention operates with data collected at or near a particular phase of the heart. The time correlation by which such a method is employed can be achieved by prospective gating.

Usually in medical imaging procedures the heart rate is not uniform during the data acquisition process. As in the discussion above with respect to FIG. 10, the preferred procedure here is to collect an electrocardiographic data set along

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with the projection data. The EKG data set can then be correlated off-line with CT scan data, using the time stamps as noted previously. Thereafter, using the time stamps and the correlations to the EKG data, the particular projection data corresponding to a selected cardiac configuration phase can be identified.

Such an adaptation to heart rate variations is well known in the art and has been used, for example, in the sector approach described above with respect to FIG. 7. Persons skilled in the art will readily appreciate the appropriate measures to be used with the present invention to compensate for the presence of heart rate variability. For example, a compensation model is employed in the technique of U.S. Patent No. 5,997,883 to Epstein et al. noted previously.

On the other hand, a further embodiment of the present invention is particularly useful in cases where heart rate variability exists. The basic approach described above is employed again, but variations in the heart rate are accommodated in the interpolation process.

FIG. 17 illustrates a typical effect on a trajectory when the heart rate varies. Trajectories 1 and 2 again represent successive portions of CT projection data. The scanning rotation also continues to have a fixed period T_g. However, unlike in FIGS. 12-13, the heart rate is now variable with a period varying around some nominal period T_h. The rightmost extent of the graph in FIG. 17 does not represent successive completions of the R-R cycle of the heart. However, like FIGS. 12-13, the trajectories in FIG. 17 wrap around to $t=0$ when they reach $t=T_h$.

Unlike FIG. 12, for example, in FIG. 17 the R-waves of different heart cycles occur at different time positions on the graph. An R-wave R_1 that begins the R-R cycle of trajectory 1 is illustrated as occurring at temporal position $t=0$ on the graph. However, an R-wave R_2 occurs at a later temporal position $t=\Delta t$. The R-wave peak at R_2 occurs at a time $T_h+\Delta t$ following R_1, while the temporal positions on the graph reflect the fact that the graph wraps around to $t=0$ at intervals of T_h. The time

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difference Δt can thus be viewed as a phase delay between the cycle beginning with R_1 and the cycle beginning with R_2.

FIG. 18 illustrates the effect of heart rate variability on the time correlations between the CT projection data and the configuration phases of the heart as indicated by contemporaneously collected EKG data. Trajectories 1 and 2 with respective R-waves R_2 and R_1 are shown as in FIG. 17. Again, a set of projection views is desired for reconstructing a useful image of the heart at a specified configuration phase. In the cardiac cycle of trajectory 1, the specified configuration phase is assumed to occur at temporal position t_1. The trajectory 1 again includes the projection view 910 having a time stamp correlated to the temporal position t_1. A fixed time delay TD is defined to be numerically equal to the temporal position t_1.

The fixed time delay TD will serve a function similar to the fixed heart cycle ratio mentioned above (represented by ϕ_0 in FIG. 12), but for the case of varying heart rate. In each successive heart cycle, the timing of the specified configuration phase will occur at the time delay TD after the R-wave of the cycle. FIG. 18 shows that the specified phase therefore occurs in trajectory 2 at a temporal position t_2 on the graph.

The trajectory 2 includes a projection view 1820 that is time stamped to correspond to the temporal position t_2. The temporal position t_2 of view 1820 is commensurately offset (by the phase delay Δt) from the time position t_2 corresponding to the projection view 910 from trajectory 1. The view 1820 nevertheless represents the heart at the specified phase, because the cycle of trajectory 2 begins at the R-wave R_2. An image reconstruction of the heart in that specified configuration will therefore utilize both the projection view 910 and the projection view 1820.

The embodiment of the invention described with reference to FIGS. 12-13 can provide data for such a missing projection view through gated reconstruction that bins the data into phases. If the heart rate is uniform, as illustrated

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in FIG. 12, then these phases occur at regular intervals T_{heart} in time. The horizontal axis in FIG. 12 consistently represents both time t and cardiac phase $_{\phi}$. This correspondence allows differences in the phases of the heart at the projection views 900, 910, and 920 to be determined directly from the temporal positions of those views on the graph.

However, heart rate irregularity is particularly common among patients undergoing cardiac care, and this creates a problem for using EKG data for gated reconstruction. As in FIGS. 12-13, this embodiment of the invention provides an additional, synthesized projection view 900 to be combined with the views 910 and 1820 in reconstructing the image. But when the cardiac cycle is irregular, the direct correspondence between temporal position and cardiac phase is destroyed.

FIG. 18 illustrates that the temporal position t_2 of the projection view 1820 is delayed relative to the temporal position of 910. This delay is induced by, and is numerically equal to, the phase delay Δt: $t_2 - t_1 = \Delta t$. It follows that when the heart rate is irregular, a given configuration phase will not occur at a regularly repeating temporal position, such as at ϕ_0. Instead, the desired phase will occur in each cardiac cycle at a time position determined by the R-wave of the cycle and the fixed time delay TD.

FIG. 19 illustrates an approach to account for the phase delay Δt in the determination of the differences between the cardiac phases. This approach enables the present invention to provide consistent projection view interpolation, in the presence of heart rate irregularity. The basic approach is the same as illustrated in FIG. 13: combine the working projection views 910 and 920 by interpolation to generate an interpolated projection view 900. Moreover, as in the case of constant heart rate, the interpolation formula will generally blend corresponding data values from initial projection views 910 and 920 based on differences between the different phases.

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The timing differences δ_1 and δ_2 in FIG. 19 correspond to d_1 and d_2 as in FIG. 13 and are again associated with the projection views 910 and 920. However, because the desired phase occurs in trajectory 2 at temporal position t_2, d_2 includes the difference between t_1 and t_2, i.e., t_2-t_1=Δt. Thus, for an irregular heart rate, the interpolation formula desirably blends the initial projection views 910 and 920 based on

$$\delta_1 = T_1 - t_1, \tag{3}$$

$$\delta_2 = t_2 - T_2 = t_1 - T_2 + (t_2 - t_1) = t_1 - T_2 + \Delta t.$$

Any of the various interpolation methods known in the art may be used for interpolation between 910 and 920 in FIG. 19, using appropriate measures of phase differences such as δ_1 and δ_2. For example, either of the formulas (1) and (2) above may be used directly by substituting δ_1 and δ_2 for d_1 and d_2, respectively. The use of a fixed delay TD ensures that the working projection views will correspond to a same phase of the cardiac cycle following the trigger phase. The procedure illustrated in FIGS. 14-16 may then be employed to generate the interpolated projection view 900.

The same delay time TD can be used to generate projection views for image reconstruction at a succession of slice positions z_0. A number of slice images can be generated to provide a reconstructed three dimensional image of the heart at the configuration phase specified by the selected delay TD. It is desirable to use a delay time TD corresponding to a cardiac phase at which the heart is nearly still. Alternatively, the approach of the invention may be further extended by performing the aforementioned three dimensional image reconstruction for each of a series of delay times TD. This alternative allows the creation of a time succession of such three dimensional images to provide a dynamic (four-dimensional) model of the heart.

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The aspect of the present invention described with reference to FIG. 10 may be implemented in various different embodiments, several of which may have particular application in dynamic imaging contexts such as cardiac imaging. An embodiment suitable for a given imaging context may be selected according to the particular imaging system hardware to be used, characteristics of the object to be imaged, image parameters to be emphasized, and so forth. Two particular embodiments of the invention will now be described in more detail. Those of skill in the art will appreciate details and desirable features of other alternative embodiments, upon considering the foregoing general description together with the particular descriptions to be presented below.

Interpolation Between Several Projection Views

FIG. 20 is a trajectory graph, similar to the graphs of FIGS. 12-13, but illustrating an alternative aspect of the invention. The embodiment illustrated in FIGS. 12-13 provided phase interpolation between two projection views selected from consecutive different data acquisition cycles, and thus falling on neighboring trajectories in the graphs. Here, for added clarity of illustration, the trajectories are labeled to indicate both their respective gantry rotations and heart cycles. Thus the label "M_N" indicates the trajectory represents a sequence of projection views from the M-th heart cycle and the N-th gantry rotation.

The alternative embodiment of FIG. 20 provides for generating an interpolated projection view 2000 by phase interpolation between several working projection views 2010, 2020, 2030, and 2040. While four working projection views 2010-2040 are shown, it will be apparent that this aspect of the invention encompasses other numbers of projection views, both more than four and less than four. Moreover, it may be seen that assignment of zero interpolation weights may effectively exclude some working projection views from the phase interpolation of a particular embodiment. For example, assignment of zero weights to the projection views 2030 and 2040 effectively reduces this alternate aspect of the invention to the

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previous aspect, in which phase interpolation is applied to two neighboring projection views.

More generally, this alternative aspect may be embodied through phase interpolation between several (e.g., three or more) working projection views. The result is again to obtain an interpolated projection view, now based on the interpolation formula

$$P_{\phi}(\theta) = \sum_{i,j} w_{ij}(\theta,\phi) \cdot P_{ij}(\theta) \qquad (4)$$

Here *i* indexes cardiac cycle and *j* indexes gantry rotation (i.e., data acquisition cycle). The equation (4) applies fully to the case of axial scanning but is not limited to such contexts, as will be seen below.

The weights $w_{ij}(\theta, \phi)$ in equation (4), some of which may be zero, may be selected based on any of various suitable weighting schemes. For example, the weighting formulas

$$w_{ij}(\theta,\phi) = \frac{w'_{ij}(\theta,\phi)}{\sum w'_{ij}(\theta,\phi)}, \text{ where} \qquad (5)$$

$$w'_{ij}(\theta,\phi) = \left[\Delta(\Phi_{ij}(\theta) - \phi)\right]^{-p} \text{ and}$$

$$\Delta(\Phi_{ij}(\theta) - \phi) \equiv \begin{cases} \left|\Phi_{ij}(\theta) - \phi\right|, & \left|\Phi_{ij}(\theta) - \phi\right| \le \frac{T_h}{2} \\ T_h - \left|\Phi_{ij}(\theta) - \phi\right|, & \frac{T_h}{2} < \left|\Phi_{ij}(\theta) - \phi\right| \le T_h \end{cases}$$

define weights $w_{ij}(\theta, \phi)$ similar to the coefficients of P′ and P″ in (1) and (2) above.

The case where the exponent is p=2, for example, achieves rapid decay with increasing phase distance of the working projection view from the desired phase. A rapid decay condition reduces the influence of more distant working projection

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views, relative to the contribution to the interpolation result from views close to the desired phase.

It is noted that the above definition of $\Delta(\Phi_{ij}(\theta)-\phi)$ accounts for the case when the distance $|\Phi_{ij}(\theta)-\phi|$ is greater than $T_h/2$, one-half the heart cycle period. Such a difference function may be applied (with changes that will be apparent to those of skill in the art) in equations (1) and (2) above, in any case where the difference ϕ_0-T_2 or the difference $T_1-\phi_0$ exceeds one-half of the heart cycle period T_h.

Those of skill in the art will appreciate that the inverse-polynomial weighting $[\cdot]^{-p}$ set forth above is only one example of a weighting function that may be applied for phase interpolation as provided by the present invention. For example, the weights $w_{ij}(\theta, \phi)$ may be defined in terms of any nonnegative monotonically decreasing function of the distance $\Delta(\Phi_{ij}(\theta)-\phi)$ such that the sum of the weights for a given θ and ϕ is unity: $\Sigma\, w_{ij}(\theta, \phi)=1$. For example, the weighting function $w_{ij}(\theta, \phi)$ may be reduced to a unit step function having value 1 at the nearest-neighbor phase $\Phi_{ij}(\theta, \phi)$ and value 0 at more distant phases. The result of this weighting choice in equation (4) would be to reduce the interpolation approach of the present invention to the nearest-neighbor substitution approach described above.

Another implementation provided by the present invention assigns non-zero weights to working projection views in pairs, with each pair comprising one view before and one view after the desired phase (i.e., the phases of each pair "sandwich" the desired phase). In such an alternative implementation it may be particularly desirable to use sandwiching with working projection views from consecutive trajectories. That is, for each of the sandwich pairs, the projection views of the pair may be chosen from consecutive data acquisition cycles to sandwich the desired phase therebetween.

Helical Scanning

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In an implementation for cardiac imaging, as described above, the invention enables reconstruction of a single slice through the heart with high resolution in time. If reconstruction is desired for more than one slice, such as for a volumetric section (for example, a volumetric image of the entire heart), then further processing is performed.

One way to achieve this further goal is to perform the previously described method for each of several slices through the heart. However, collection of the scan data to be used for each slice involves multiple rotations of the gantry. For the example illustrated in FIG. 8, three complete scanning rotations would be needed for each slice.

Such an operation of multiple rotations for multiple slices would require an undesirably long data collection time. In particular, collection of data for all the slices through the heart would be difficult to achieve in one breath hold (20-60 seconds), at least with the current CT technology. Such an approach would also deliver to the patient an undesirably large X-ray dose. Thus, at least for dynamic contexts such as cardiac imaging, the axial scanning arrangements illustrated in FIGS. 2-3 may have disadvantages.

FIG. 21 illustrates a source-detector assembly 2100 for a desirable alternative to axial scanning, called helical scanning. The principal features of assembly 2100 are analogous to the components of assemblies 200 and 300 in FIGS. 2 and 3, respectively. A subject 2102 (here illustrated as a human patient) is illuminated by an x-ray beam 2104 while disposed on a (possibly movable) table 2108. A gantry 2112 supports an x-ray source 2114 that generates the imaging x-ray beam 2104. However, unlike the fan beams 204 and 304 described previously, beam 2104 is a so-called cone beam that spreads (or "fans") in two generally orthogonal directions as the beam is projected away from the source 2114.

The particular assembly 2100 of FIG. 21 corresponds to the third generation axial assembly 200 of FIG. 2. Specifically, the gantry 2112 also supports

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a detector array 2116 comprising multiple detector elements 2118, and both the source 2114 and the detector array 2116 are transported around the subject 2102 along respective circular paths as the gantry 2112 rotates. The detector array 2116 and the source 2114 are both fixed to the gantry 2112. The detector 2116 thereby remains opposite the source 2114, relative to the subject 2102, during the rotation.

Unlike detector array 216, however, the array 2116 is a so-called multi-row detector comprising several rows of detector elements. The array 2116 thereby provides a two dimensional detection area, which corresponds to the spread of the cone beam 2104 in two directions. Accordingly, at each (lateral) detector position of a single row detector array (such as array 216 in FIG. 2), the array 2116 comprises an entire set of detector elements arranged in a column generally parallel to the axial direction z.

FIG. 22 shows a schematic diagram of the detector elements of a multi-row detector such as detector array 2116. In the illustrated example, each column of the array 2116 comprises four detector rows. Each detector has a thickness of Δ_d.

Helical scanning relaxes the requirement of axial scanning systems that the axial position of the gantry is fixed at a single point throughout the data collection cycle. Instead, the entire gantry (source and detector array) translates axially (in the z direction) relative to the patient. This mode of operation allows a single scan to cover the entire organ or structure under study. Thus, the motion of the gantry, as well as the individual detector elements, traces a helix. The extent of translation in the z direction (as a fraction of detector thickness Δ_d) per gantry rotation is called "pitch" and is denoted by "p" in FIG. 21. Thus, the axial position of the *k*-th detector row can be written as

$$z_k(t) = p\Delta_d \frac{\omega t}{2\pi} + k\Delta_d .$$

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A helical/cone beam CT scanning system provides advantages for performing a volumetric reconstruction of the heart. For example, a multi-row detector such as detector array 2116 can collect several times more x-ray data from each scanning rotation. The axial position of the cone beam 2104 also advances continuously during the scanning operation, so that each detector element 2118 traces a helical path around the subject 2102. In this manner, the data collection proceeds continuously as the cone beam 2104 advances axially, rather than being repeatedly interrupted for a next translation maneuver.

FIG. 23 illustrates a complication that arises with helical scanning. The rotations 1, 2, and 3 represent successive loops of the helical advance of a four-row detector array such as array 2116 shown in FIGS. 21-22. As time t evolves, each scanning rotation progresses from a 0° view angle to a 360° view angle. Further, the angle 360° for a given rotation coincides with the view angle 0° of the succeeding rotation.

However, the helical advance of the gantry during the scanning process causes the detector elements of the multi-row detector to be displaced axially during each rotation. The locations of the detector rows of a three-row detector in the z direction are shown in FIG. 23 in the z-t domain. The axial position of each detector row therefore changes, both between rotations and within each rotation. Still, each of the detector rows in the multi-row detector defines data corresponding to a proper projection view, i.e., a projection view representing attenuation data for a single axial position.

The axial displacement of the detector positions in helical scanning entails additional processing (rebinning) of the collected projection data to assemble projection views conformable to the standard image reconstruction methods. One approach is initially to reformat the helically skewed data from the multi-row detector into a sequence of sinograms each corresponding to a single axial position z. This rebinning procedure typically entails an interpolation procedure between detector element values of neighboring detector rows. An additional, phase interpolation

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procedure of the present invention is also performed to obtain projection data for the missing projection views at each axial position.

FIG. 24 illustrates an alternative approach in which each data row of the three-dimensional helical projection data is tagged with corresponding phase information. Thus, following FIG. 11, the phase of the projection at view angle , cardiac cycle i, gantry rotation j, and detector row k is represented as Φ_{ijk}. The projection data may also be tagged with Z-axis position information $Z_{ijk}()$ based on the geometry of the detector rows, the relative speed of gantry and patient, and the gantry rotation rate. In FIG. 24 the diagonal line represents the common trajectory followed by each detector row in z as time evolves. The values $np^*\Delta_d$ on the vertical axis represent the accumulated number of data rows obtained after the corresponding number of gantry rotation periods (T_g, $2T_g$, $3T_g$, etc.). The slope of the diagonal line is determined by the table speed.

FIG. 25 shows a flow diagram illustrating a procedure to implement the present invention in the context of helical scanning. An operation 2510 cross-references the view angles of the helical projection data and the timing of the cardiac cycle. This may entail tagging the set of projection data for each view angle with timing information. The operation 2510 thereby correlates the projection data sets to the cardiac cycle phases to which the respective data sets correspond. In the case of a multi-row detector, each projection data set will comprise several rows of projection data for each view angle.

A particular cardiac phase is selected for reconstruction at an operation 2520. Because the helical scanning process collects scan data over a range of axial positions, an axial position z_0 of the slice to be reconstructed is also selected at an operation 2530. An initial view angle is selected at an operation 2540 for processing of the helical data.

An operation 2550 selects a set of neighboring scanning rotations for the selected cardiac phase and the selected view angle. This operation is described in

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more detail below with reference to FIGS. 26-28. Briefly, operation 2550 relates to the fact that the helical scan data are collected as the axial position of the gantry advances through multiple rotations. A first stage toward determining working projection views is to identify from the helical projection data the scanning rotations for which the projection data are most relevant to the missing projection view.

An operation 2560 determines working projection views for the scanning rotations selected in the operation 2550. This determining operation is described in greater detail below with reference to FIGS. 29-30. Operation 2560 relates to the fact that the helical scan data from a multi-row detector is desirably conformed into projection views for the selected slice position.

When the working projection views have been determined at operation 2560, the procedure of FIG. 25 advances to an operation 2570. In this operation, an interpolated projection view is generated from the working projection views determined in the operation 2560. The operation 2570 may be the same phase interpolation (i.e., interpolation in time) described above with respect to operation 1460 of FIGS. 14 and 16. An operation 2580 determines whether the current view angle is the last view angle for which a projection view is needed for reconstruction of the selected slice. If more view angles remain, the procedure advances to an operation 2590 where the next view angle is selected. The procedure then returns to operation 2550.

FIG. 26 shows a flow diagram illustrating an exemplary sequence of operations for performing the operation 2550 of FIG. 25. The context for this procedure is that the helical projection data comprise data for a succession of scanning rotations each including the selected view angle. However, because the cardiac cycle will not be synchronized with the scanning rotations, the data for the selected view angle from different scanning rotations generally will represent the heart at different cardiac phases.

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Operations 2610 and 2620 determine particular helical projection data (such as by selecting particular scanning rotations) for which the selected view angle corresponds to respective cardiac phases near the selected phase. The operation 2610 determines such data for a nearby phase timing prior to the timing of the selected phase, and the operation 2620 determines data for a nearby phase subsequent to the selected phase.

For example, with reference to the trajectories of FIG. 8, the trajectories 3 and 2 would be selected as neighbors for (i.e., before and after) the selected phase t_0, for all view angles θ between 0° and 60°. For θ between 60° and 180°, trajectories 1 and 3 would be selected; for θ between 180° and 300°, trajectories 2 and 1 would be selected; and for θ between 300° and 360°, trajectories 3 and 2 would be selected. It is desirable for the procedure to select those scanning rotations for which the selected view angle occurs at a cardiac phase closest to the selected cardiac phase.

FIGS. 27-28 illustrate the determinations of operations 2610 and 2620. In FIG. 27, each of scanning rotations 1, 2, and 4, the timing of the selected phase is denoted as ϕ_0. The scanning rotation 3 lacks an occurrence of the selected phase, reflecting the fact that in the illustrated example the cardiac cycle period T_h is longer that the scanning rotation period T_g. The selected view angle is denoted θ_v and occurs in every rotation, including rotation 3.

FIG. 28 illustrates determination of scanning rotation sets for operations 2610 and 2620. In a preferred embodiment, the rotations are ones in which the selected view angle occurs at a cardiac phase close to an occurrence of the selected phase. FIG. 28 shows that the phase differences between the phase at the selected view angle θ_v and the selected phase ϕ_0 are represented as phase differences $\Delta\phi$.

The designation of phase differences $\Delta\phi$ emphasizes that the present invention may determine a working projection view based on the difference between

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the phase of the heart at the working view and the desired phase. An interpolation rule used in the present invention may account for the relative phase differences of two working projection views and may give greater weight to a working view that is closer in phase than a working view that is farther away. As indicated above with reference to FIGS. 17-19, the actual phase difference may be better determined by a delay following a most recent trigger wave in the EKG (such as an R-wave), rather than a uniform phase timing such as timing ϕ_0 in FIG. 12.

Returning to FIG. 28, the view angle θ_v in rotation 1 occurs at a phase delay $\Delta\phi_1$ away from the occurrence of the phase ϕ_0. In rotation 2, view angle θ_v occurs $\Delta\phi_2$ away from ϕ_0 in rotation 1 and $\Delta\phi_3$ away from ϕ_0 in rotation 2. Similarly, in rotation 3 θ_v occurs $\Delta\phi_4$ away from ϕ_0 in rotation 2 and $\Delta\phi_5$ away from ϕ_0 in rotation 4. θ_v in rotation 4 occurs $\Delta\phi_6$ away from ϕ_0 in the same scanning rotation. Of course, additional scanning rotations will generally provide additional occurrences of θ_v at corresponding phase differences $\Delta\phi$ away from ϕ_0.

The selection of neighboring scanning rotations in operation 2550 (see FIG. 25), performed in operations 2610 and 2620 of FIG. 26, may select a pair of rotations for which the selected view angle θ_v occurs at a timing close in phase to the desired phase ϕ_0. In a particular case, θ_v may occur in the selected rotations at the closest phases before and after phase ϕ_0, respectively, among the collected projection data. Thus, rotation 4 will be selected because θ_v occurs closest in phase to ϕ_0, of the available rotations. The occurrence of θ_v in rotation 3 is the closest occurrence after an occurrence of ϕ_0, among the available rotations. It should be observed at this point that the selected rotations 3 and 4 are temporally consecutive data acquisition cycles, a natural consequence of selecting the closest trajectories before and after the desired phase.

It follows that the exemplary embodiment illustrated in FIG. 28 determines the helical projection data in operation 2610 as the data at θ_v in rotation 4. The data determined in operation 2620 are, in like manner, the data at θ_v in rotation 3.

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In summary, the illustrated embodiment of the procedure selects the nearest neighbor scanning rotations before and after the selected phase. The possibility exists to interpolate between view angles corresponding to other scanning rotations, as well, as noted above with reference to FIG. 20. Such alternatives will be described in more detail below with reference to FIGS. 31-36.

FIG. 29 shows a flow diagram illustrating an exemplary sequence of operations for performing the operation 2560 of FIG. 25. The result of these operations is to determine for each selected scanning rotation a projection view representing the subject at the selected axial position. As noted above, the helical scan data is usually collected with a multi-row detector and cone beam.

An operation 2910 selects an initial scanning rotation from the selected scanning rotations for which working projection views are to be determined. The selected axial position will generally fall between the axial positions for two detector rows of the selected scanning rotation at the selected view angle. FIG. 27 shows that the axial position of each detector row advances as the view angle of the rotation increments from 0° to 360°. For the selected view angle, operation 2920 determines from the selected scanning rotation the two rows closest to the selected position z_0.

FIG. 30 is a time evolution diagram, similar to FIGS. 27-28, showing the helical projection data determined in the procedure of FIG. 26. As seen in FIG. 30, the helical projection data will usually comprise several rows of data corresponding to the rows of detector elements arranged successively in the axial direction. In the typical case, as illustrated in FIG. 30, none of the selected data rows will provide a projection view at the selected axial position z_0. This is a common occurrence with helical scanning data and arises because of the axial translation of the detector array during the scanning rotation. A projection view for the selected position z_0 will therefore be constructed from the existing helical projection data.

FIG. 30 also illustrates the scanning rotations and data rows that may be selected in operations 2910 and 2920. For the purposes of this illustration, it is

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assumed that the scanning rotation 3 is the selected initial scanning rotation. The two data rows 3010 and 3020, respectively below and above z_0 in the axial direction Z, comprise the neighboring detector row data selected in the operation 2920.

Returning to FIG. 29, projection data for an interpolated projection view at the selected position z_0 are then computed at an operation 2930. Here the interpolated projection data are generated by interpolating in z (the axial direction) between the neighboring row data at each detector position along the selected rows. In some respects this computation resembles a grid transformation operation, whereby the available data are converted to projection data for a different grid. Such transformations are well known in the art, and the various available alternatives for carrying out the corresponding computations will not be detailed here. In a typical such alternative, the data values of the z-interpolated projection view are obtained according to a formula such as

$$P_{ij}(\theta, z_0) = \sum_{ijk \ni |Z_{ijk}(\theta) - z_0| \le \Delta_d} \omega_k(z_0) \cdot P_{ijk}(\theta), \text{ where} \qquad (6)$$

$$\omega_k(z_0) = G\left(\left|Z_{ijk}(\theta) - z_0\right|\right), \ \sum_k \omega_k(z_0) = 1.$$

Here k indexes the rows of the multi-row detector array, $Z_{ijk}(\theta)$ is the z-location of the projection view $P_{ijk}(\theta)$, and Δ_d is the collimation (which, as noted previously, is the inter-row distance). It is also noted that the projection views $P_{ijk}(\theta)$ for given θ, i and j have the same phase $\Phi_{ij}(\theta)$ for all rows k. This commonality arises because in such a case the projections of all the rows are collected at the same moment in time.

The weights $\omega_k(z_0)$ may be defined in terms of a function $G(\cdot)$ of the distance $\left|Z_{ijk}(\theta) - z_0\right|$, where G is a non-negative monotonically decreasing function of its argument. For example, G may be a linear function of the distance $\left|Z_{ijk}(\theta) - z_0\right|$. The idea behind this z-interpolation, like the phase interpolation described previously, is that the closer a projection view is to z_0 (or ϕ_0), the more that

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projection view contributes to the interpolated projection view. As with the previous discussion of weights for phase interpolation, those of skill in the art will appreciate that many weighting schemes may be employed to carry out z-interpolation with the present invention.

An operation 2940 determines whether working projection views are to be determined for more scanning rotations. If so, then the procedure advances to an operation 2950 where the next of the selected scanning rotations is selected for interpolation. For example, in FIG. 30 the next scanning rotation would be scanning rotation 4. The procedure of FIG. 29 then returns to operation 2920. The two data rows 3030 and 3040, respectively below and above z_0, comprise the neighboring detector row data selected in the operation 2920. The operation 2930 then interpolates between rows 3030 and 3040 to generate the second working projection view at the selected axial position z_0.

In the procedure of FIG. 26 the operations 2610 and 2620 will be performed twice. At the completion of the procedure illustrated in FIG. 29, there will have been determined two (or more) separate working projection views each computed by interpolation in z between neighboring detector rows of the respective scanning rotation data. At this point the procedure of FIG. 25 continues as described above.

Flexible Projection Data Processing

A further alternative embodiment of the invention will now be described with reference to FIGS. 31-35. A procedure of this alternative bears some similarities to the procedure of FIG. 14 above. The result to be obtained may be a 3-D image of the patient's heart at a desired cardiac phase ϕ_0. A three-dimensional image (a volumetric representation based on several slice images) of the subject's heart may be obtained through this alternative embodiment by reconstructing 2-D slices for a range of z-locations (z_0). For each two-dimensional slice, the system may

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obtain a slice image corresponding to the given phase ϕ_0, as well as the axial position of the slice.

FIG. 31 is a flow diagram illustrating a procedure 3100 of this alternative embodiment of the invention for the case of helical scan data. In an operation 3110 the three-dimensional projection data are tagged with phase and z-location information. Based on the temporal location of the identified R-wave peaks, as described above with reference to FIG. 11, each projection view is assigned a cardiac phase Φ_{ijk}. In this operation the gantry period T_g is also used to determine the gantry rotation of the projection view. Similarly, the z-locations of the projection views are determined based on the relationship between the gantry period T_g and the table speed, as indicated above with reference to FIG. 24. The phase and z-location tags are used in the subsequent operations of the procedure 3100.

An operation 3120 selects a cardiac phase at which a slice image of the patient's heart is to be reconstructed. A corresponding axial position z_0 for the slice image is selected in an operation 3130. These operations specify the slice image and enable the appropriate projection data to be identified by reference to the phase and location tags.

An operation 3140 determines, from among the helical projection data, the set of projection views from which an interpolated projection view for the slice image may be generated. Given the selected z-location z_0, the projection views that possibly could contribute to the interpolation result of equation (4). As noted above, for a given axial position either one or two data rows of the helical projection data correspond to row positions that are closest to the selected axial position z_0. The projection data were tagged with location information in the operation 3110, and therefore the data rows can be searched for the one or two nearest neighbors to z_0.

Operation 3150 determines a reconstruction range in which to obtain a complete set of projection views for the selected slice image. The operation 3170 determines working projection views for the selected view angle by interpolating in

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the z-direction between the neighboring projection views as determined by the location tags $Z_{ijk}(\theta)$. This operation determines a reconstruction range, i.e., a range of view angles (the range having extent 180°+fan angle) from among the full range [0°, 360°). Here a "reconstruction range" comprises a plurality of discrete view angles, because the projection data are sampled in discrete sampling intervals. A set of projection data is said to "cover" a given reconstruction range if the set of projection data comprises a projection view at each of the discrete view angles of the reconstruction range.

The reconstruction range is selected as a subset of the projection views covering the selected axial position (see operation 3140) for which the total phase distance from the selected phase ϕ_0 is a minimum. The operation 3150 will be described in more detail with reference to FIG. 33. An operation 3160 selects an initial view angle at which an interpolated projection view will be generated.

Operations 3170 and 3180 are repeated for each view angle in the selected reconstruction range. This interpolation may be carried out substantially as described above with reference to FIG. 29.

The operation 3180 performs phase interpolation between the z-interpolated projection views obtained from the operation 3170, using the selected interpolation rule of the form (4) above. Alternatively, the interpolations of operations 3170 and 3180 may be performed in an integrated computation, using an interpolation rule such as

$$P_\phi(\theta) = \sum_{i,j,k} w_{ij}\omega_k P_{ijk}(\theta). \qquad (7)$$

It is further noted that the separated weight $w_{ij}\omega_k$ may be replaced with an integrated weight Ω_{ijk}

The procedure 3100 advances from the operation 3170 to an operation 3180 that determines whether more view angles in the selected reconstruction range

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remain for interpolated projection views to be generated. If so, then an operation 3190 selects the next view angle and the procedure loops back to the operation 3150. If not, the procedure 3100 returns.

FIG. 32 is a flow diagram illustrating details of an exemplary procedure for carrying out the operation 3140 of FIG. 31. An operation 3210 selects an initial time stamp corresponding to an initial sampling interval of the (three-dimensional) helical projection data. This identifies the projection data rows generated first in time among the helical data.

From the operation 3210 the procedure of FIG. 32 enters an iterative loop in which rows of data are examined for possible inclusion in the set of selected projection views. An operation 3220 determines whether any data row corresponding to the current time stamp is tagged with a z-location within the collimation distance Δ_d from the selected axial position z_0. If such a row is identified, the row is selected for the set of projection views in an operation 3230.

The procedure of FIG. 32 advances from the selection operation 3230 to an operation 3240 in which it is determined whether the projection data comprise a second row within the collimation distance Δ_d from the z-position z_0. If so, the second row is selected for the set of projection views. As noted above, for any given data sampling interval (i.e., any given time stamp) will correspond to at most two data rows tagged with z-locations within the collimation distance from a selected axial position.

If the determination at either the operation 3220 or the operation 3240 is negative, then the procedure advances directly to an operation 3260. The operation 3260 determines whether all the time stamps for the collected projection data have been considered. If not, then the procedure advances to an operation 3270 where a next time stamp is selected. From the operation 3270 the procedure loops back to the determination at the operation 3220. If the determination at the operation 3260 is affirmative, then the procedure returns. Alternatively, instead of looping back based

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on the determination of operation 3260, the procedure of FIG. 32 may instead continue until a row of data has been selected at a time stamp and no row of data is selected at a subsequent time stamp, or until all of the time stamps have been considered, whichever occurs first. This alternative may be more efficient because a final block of rows that comprises no selectable rows will not be searched.

FIG. 33 is a trajectory graph, similar to the graph of FIG. 20, for illustrating the operation 3150 of FIG. 31. The filled circles 3310 each represent projection data corresponding to a respective data sampling interval. The data acquisition cycles of the imaging system 100 provide several trajectories 1, 2, 3 of projection data. Each trajectory, although discretized in time and hence also in view angle, nevertheless covers the full range [0°, 360°) of view angles. Moreover, for each discrete view angle in the range [0°, 360°), the projection data comprise several sets 3310 of projection data having time stamps corresponding to the given view angle. Thus, as in FIG. 20, an interpolated projection view could be generated for each discrete view angle from the existing sets of projection data at that view angle.

On the other hand, as noted above, current reconstruction algorithms generally can produce high quality image reconstructions with projection data covering less than the full range [0°, 360°). The projection views should cover an angular sector of at least 180° plus the fan angle. FIG. 33 illustrates that this condition may be satisfied by several different sets of projection views covering different sectors of view angles. The several trajectories 1, 2, 3, etc., therefore comprise more projection data than is necessary for the desired image reconstruction.

This surplus of projection data presents a potential opportunity for optimizing the image quality by carefully selecting the reconstruction range for the desired image. Here a reconstruction range Θ_r is simply the range of view angles of the projection views from which the slice image will be reconstructed. The perspective of the projection data afforded by the trajectory graph of FIG. 33 raises the possibility that different reconstruction ranges may provide reconstructed images with different features.

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Yet another aspect of the present invention provides an approach for determining a reconstruction range that will optimize some data parameter having an influence on image quality. In one implementation of this aspect of the invention, a reconstruction range is selected that has a minimum total phase distance from the desired phase. Here, "minimum total phase distance" means the smallest distance value defined by the following formula:

$$D(\theta_1,\theta_2)=\sum_{\theta\in R_r=[\theta_1,\theta_2]} d(\theta,\phi) \tag{8}$$

where the reconstruction range R_r extends between beginning and ending view angles θ_1 and θ_2, respectively. The total phase distance is a "separation measure" for the reconstruction range, because the total phase distance measures a separation (in phase) between the existing projection views of the reconstruction range and an ideal set of projection views (e.g., all at the desired phase). The value $d(\theta,\phi)$ is selected as the minimum phase distance between the phase of the current projection view and the desired phase, as follows:

$$d(\theta,\phi)=\arg\min_{i,j}\left|\Phi_{ij}(\theta)-\phi\right|. \tag{9}$$

Those of skill in the art will appreciate that the reconstruction range R_r may begin at an angle θ_1 that is actually larger than the ending angle θ_2, due to the periodicity of θ_1. In such a case the representation $[\theta_1, \theta_2]$ for the reconstruction range R_r in equation (2) above may be replaced by the corresponding representation $R_r=[\theta_1, 2\pi)\cup[0, \theta_2]$.

In the foregoing particular example the detector array has four rows of detectors. In this exemplary case it follows from simple geometry that the number of gantry rotations contributing projection views for a given z-location is determined by 4/p, where p is again the pitch of the helical scan. The pitch p may be selected to be small enough that multiple projection views are generated for the same view angle,

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although from different gantry rotations and cardiac cycles. Depending on the heart rate, these projection views will represent the heart in a distribution of cardiac phases.

Therefore, in a first procedure, the temporal (phase) distance d_{ij} of each projection to the reconstruction (target) phase ϕ_0 will be determined. Each of these phase distances indicates a separation (in phase) between the projection view and an ideal projection view (at the desired phase), and thus each is a "separation value" for the respective projection view. Then, for each view angle, the minimum temporal distance is found and used with equations (8) and (9) to determine the start angle θ_s and the end angle θ_e of the least-distance reconstruction range. The result is a reconstruction range with a subset of projection views that are closest in phase to the reconstruction phase ϕ_0.

FIG. 34 is a flow diagram illustrating a procedure of this further aspect of the invention for determining such a reconstruction range. An operation 3410 computes the phase difference d_{ij} for each projection view in the selected set of projection data. An operation 3420 then selects a projection view closest in phase to the desired phase ϕ_0, for each view angle. A total D_R of these minimum distances is computed at an operation 3430 for each potential reconstruction range in the full sector [0°, 360°). A particular reconstruction range whose total distance D_R is a minimum relative to the other reconstruction ranges is selected in an operation 3440, and the procedure of FIG. 34 returns.

FIG. 35 is a flow diagram illustrating an exemplary procedure of the invention for determining the interpolated projection views for a selected reconstruction range. An operation 3510 selects an initial view angle in the selected range. It is noted that the reconstruction range may be represented by an angular interval $[\theta_s, \theta_e]$, so that the initial view angle may be θ_s. An operation 3520 interpolates between the row data of the projection views selected for the view angle. An operation 3530 determines whether more view angles remain at which to generate

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interpolated projection views. If more view angles remain, an operation 3540 selects the next view angle, and the procedure loops back to the operation 3520.

FIG. 36 is a flow diagram outlining an overall procedure of the invention for generating a set of slice images for a corresponding range of axial positions z. Where the set of slice images comprises a plurality of images, this procedure effectively provides for generating a volumetric image of the object of interest. The direct result of the particular procedure as illustrated is a three-dimensional representation of the patient's heart at a selected phase of the cardiac cycle. Persons of skill in the art will appreciate that this basic procedure may be employed for a range of selected phases to generate a dynamic model of the patient's heart, for purposes such as dynamic functional assessment.

An operation 3610 selects the desired cardiac phase ϕ_0. An operation 3620 similarly selects a range of axial (z-axis) locations for the slice images to be generated. An operation 3630 tags the projection data with phase identification information and z-location information, as described previously with reference to FIGS. 11 and 24. An operation 3640 selects an initial slice location (z_0).

Operation 3650 generates interpolated projection views for the selected slice by phase interpolation, as provided by the various aspects of the present invention. A complete set of projection views is thereby generated for the selected slice, perhaps with supplementation from the existing views of the projection data. Operation 3660 performs reconstruction on the complete set of projection views, using any of various well-known methods for tomographic image reconstruction. An operation 3670 determines whether more slice images remain to be generated. If so, the procedure advances to operation 3680 where the next slice position is selected, and the procedure then returns to the operations 3650 and 3660.

A Technique for Re-ordering Data in the Phase Domain

The foregoing exemplary embodiments illustrate an aspect of the invention that provides advantages for tomographic imaging of objects in motion.

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This aspect of the invention provides for reconstruction of a tomographic image from projection views that have been processed to account for dynamic behavior of the imaged object during collection of the projection data [$\theta(n)$, $Z(m)$].

The examples described above further illustrate that such processing to account for dynamic behavior may be carried out in various alternative ways. For example, the adaptive processing approach of the first embodiment described above is oriented toward independent sets of projection data where each set corresponds to a single axial position z. In this sense, the first embodiment may be described as "position driven." When the raw data [$\theta(n)$, $Z(m)$] are obtained by helical/cone beam scanning, further processing (rebinning) may be carried out to assemble the helically skewed data into a sequence of such independent sets for successive axial positions. This rebinning procedure typically entails an interpolation procedure between detector element values of neighboring detector rows, such as z-interpolation as described above.

An additional technique for preprocessing the raw projection data will now be described. Such preprocessing may be used with the present invention and particularly with "position driven" embodiments as noted above.

This additional technique proceeds from the further observation that useful information potentially exists in relationships between helical scan data in both space and time. The rebinning procedure noted above illustrates that the spatial proximity of adjacent detector rows has been used to synthesize projection data corresponding to a particular axial position. The technique to be described uses the further discovery that the selection of appropriate subsets of the three-dimensional projection data can allow additional information to be extracted from relationships between the raw data collected in different gantry rotations.

One source of this additional information may be the potential for overlap between the helical scan paths of various detector elements in a multi-row detector array. However, it has been recognized also that other relationships may

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exist between the raw data of different gantry rotations. A particular instance of such relationships will now be described in conjunction with an exemplary embodiment of the present additional technique in the particular context of volumetric cardiac imaging.

FIG. 37 is a flow diagram illustrating a general procedure provided by the present additional technique. An operation 3710 is the basic data collection operation for obtaining three-dimensional projection data. If the projection data are generated with a helical scanning system comprising or having a source-detector assembly such as the assembly 2100, then the operation may comprise several rotations of the gantry 2112 to execute multiple data acquisition cycles. In any case, the operation 3710 obtains volumetric projection data representing the imaged object over a plurality of data acquisition cycles.

In an operation 3720, the three-dimensional projection data are analyzed to determine (for example, to select) a particular set of projection views at a selected view angle for each data acquisition cycle. It is desirable to select the view angles for this operation 3720 according to a time dependent feature (i.e., a "dynamic behavior") of the object being imaged. The particular sets of projection views may then be selected to satisfy a predetermined relationship for the time dependent feature between the different sets. A particular case of this determining operation will be described below with reference to FIGS. 40-42.

An operation 3730 provides a reconciliation between the axial positions at which the projection views of a given set represent the object and the axial positions at which the stacked slice images are to represent the object. This reconciliation is typically helpful because the helical projection data are axially skewed within each rotation data set. Thus, with reference to FIG. 23, it will be likely that none of the detector rows will coincide in axial position with a specified position, at least when the view angle θ is chosen according to some other criterion. Thus, to generate projection views representing the object at the specified axial position, a

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spatial interpolation (such as the z-interpolation described above) is typically carried out in the operation 3730.

An operation 3740 generally completes the procedure by reconstructing a number of slice images (usually several, but possibly only one or two) at the respective specified axial positions. For each slice image, this operation entails selecting projection views from respective ones of the sets of projection views (or from the reconciled sets of projection views). In this way, each slice image may be reconstructed from several projection views representing the object at different view angles but at the same specified axial position.

A particular embodiment of the present additional technique will now be described in the context of cardiac imaging. Persons of skill in the art will appreciate, however, that this technique can also be applied in other medical and non-medical imaging contexts where a time dependent feature of the three dimensional projection data implicitly carries additional information about the imaged object.

As noted above, in the simplest case of cardiac imaging, it may be assumed that the heart rate is constant while the scan data are collected. The desired phase of the heart's cycle of configurations then occurs in each cardiac cycle at a fixed fraction of the heart period T_h following the preceding R-wave. For a given cardiac cycle, a projection view corresponding to the desired heart phase may be identified by reference to the fixed fraction and the time stamps correlating to the cardiac R-wave that begins the cardiac cycle.

The assumption of regular heartbeat simplifies the process of cross-referencing the projection data and the EKG data. In particular, for each R-R heart cycle the desired phase of the heart occurs at the same time t_0 after the R-wave of the cycle. The simplifying assumption of regular heart rate thus creates an assumed correlation between the time stamps of the row data and the respective phases of the cardiac cycle.

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However, usually the heart rate is not uniform during the data acquisition process. The preferred procedure is then to collect an electrocardiogram (EKG) data set along with the helical scan data. The EKG data set can then be correlated off-line with CT scan data, using the time stamps associated with the raw volumetric projection data. Thereafter, using the time stamps and the correlations to the EKG data, the particular projection data corresponding to a selected cardiac configuration phase can be identified, as in the embodiments described above.

Such an adaptation to heart rate variations is well known in the art and has been used, for example, in the sector approach described above with respect to FIG. 6. Persons skilled in the art will readily appreciate the appropriate measures to be used with the present additional technique to compensate for the presence of heart rate variability. For example, a compensation model is employed in the technique of U.S. Patent No. 5,997,883 to Epstein et al. noted previously.

On the other hand, an embodiment of the present additional technique is particularly useful in cases where heart rate variability exists. It is known that in most cases where the heart cycle duration varies, the systole period of the cardiac cycle is relatively stable. In other words, the portion of the cardiac cycle that changes in duration most commonly is the diastole period, when the heart is in a relaxed state. This fact can be used to develop a selection criterion for selecting sets of projection views, as in the operation 3720 of FIG. 37.

FIG. 38 depicts timing diagrams that illustrate the determination of a trigger delay TD with which to select the projection data sets. In trace A of FIG. 38, the R waves of successive cardiac cycles occur at irregular times, due to the heart rate variability. Trace B of FIG. 38 shows the corresponding displacement of a coronary artery to be imaged.

During the systole period, the displacement is substantial and will tend to create motion inconsistencies in the projection data. However, if a fixed time TD is measured after each R wave, it can be seen that the heart has entered the quiescent

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diastole period. As trace B of FIG. 38 illustrates, the duration of the diastole period may vary substantially from cardiac cycle to cardiac cycle. However, the entering portion of the diastole occurs reliably at the delay time TD after the R wave.

Trace C of FIG. 38 illustrates the timing of trigger signals by which to select the sets of projection views from the three-dimensional projection data. By generating a trigger signal at a fixed trigger delay TD after each R wave, sets of projection views can be selected from the volumetric data to represent the heart in a same phase of the cardiac cycle. The trigger delay can be chosen so that the particular phase is a phase at which the heart is nearly still, thereby enhancing the consistency of the selected projection data sets.

Different trigger delays can be used to generate a four-dimensional model of the heart. The foregoing aspects of the present invention, such as the first embodiment described above, may be employed to generate interpolated projection views for this purpose. For a given phase of the desired four-dimensional model, a projection view at a selected view angle and a selected axial position may be synthesized by interpolating between projection views at nearby phases.

FIG. 39 is a flow diagram illustrating a procedure of the present technique as applied in the foregoing context of cardiac imaging. A trigger delay TD is set to a specific value in an operation 3910, thereby determining the particular phase of the heart for the three-dimensional image reconstruction.

As can be seen from FIG. 23, the trigger delay TD will typically correspond to a different view angle θ for each of the scanning rotations (data acquisition cycles ROTATION 1, ROTATION 2, etc.). An operation 3920 therefore identifies the trigger angles θ_i for the corresponding rotational data sets. An operation 3930 collects the raw data $[\theta(n), Z(m)]$ at the corresponding trigger angles θ_i, using the time stamp correlations between the EKG data and the projection data.

An operation 3940 selects the axial positions z_i at which the one or more slice images are to be reconstructed. The positions z_i may be chosen to coincide

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with the successive axial positions of one of the selected projection data sets, although the helical skew of the volumetric projection data will generally prevent such coincidence for the other sets. An operation 3950 then completes the reconciliation of the axial positions of the selected projection data sets with the specified axial positions for the slice images, by interpolating the collected projection data sets in z. The reconciled projection data sets can then be input to the reconstruction process to generate the desired slice images.

FIG. 40 shows a time evolution diagram similar to the diagram of FIG. 23, but with the trigger delay TD indicated after the R waves R_1, R_2, and R_3. In the illustrated example, the gantry rotation period T_{gantry} is less than the nominal period of the cardiac cycle. Therefore, triggers t_1 and t_2 occur in rotations 1 and 2, respectively, but trigger t_3 does not occur until rotation 4. A different choice for TD would result in different locations of the triggers t_i.

FIG. 41 shows that the triggers t_i determine trigger angles θ_i in the rotations 1, 2, and 4. Each selected trigger angle θ_i determines a corresponding set of projection views in the time stamped projection data. For example, θ_1 determines the projection views 4112, 4114, 4116, and 4118, which happen to correspond to the first through fourth detector rows of the multi-row detector array. The trigger angle θ_2 determines the projection views 4122, 4124, 4126, and 4128 from rotation 2. The trigger angle θ_3 determines the projection views 4132, 4134, 4136, and 4138 from rotation 4.

A notable point is that all of the projection views 4112 through 4138 represent the imaged heart in the same phase of the cardiac cycle. This is achieved by determining the sets of projection views from the raw data, rather than selecting a specified axial position for the desired image and then searching for suitable projection views in the raw data.

FIG. 42 shows the selected sets of projection views at their respective view angles relative to a single cycle of view angles θ. Due to the axial skewing of

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the raw projection data, the several projection views 4112 through 4138 correspond to different axial positions z. Reconstruction of a slice image at a specified axial position therefore will typically entail reconciliation of the selected projection view sets. A reconciled set of projection views is thereby selected to representing the heart at the same view angles θ_1 through θ_3, but at a single specified axial position z.

Various implementations of the invention described herein above have been tested with clinical cardiac data. These results demonstrate that the invention can noticeably reduce the streaks and other artifacts that occur when the sector approach is applied.

As this invention may be embodied in several forms without departing from the spirit or principal characteristics thereof, the present embodiments are therefore illustrative and not restrictive. Those skilled in the art will appreciate that changes may be made to these embodiments without departing from the principles and spirit of the invention. Accordingly, the scope of the invention is defined by the appended claims rather than by the description preceding them, and all changes that fall within the metes and bounds of the claims, or equivalents of such metes and bounds thereof, are therefore intended to be embraced by the claims.

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WHAT IS CLAIMED IS:

1. A tomographic image generation method, comprising:

determining a plurality of working projection views (910, 920) of an object (106) at a selected view angle based on initial projection data collected in respective different data acquisition cycles; and

interpolating between the working projection views (910, 920) to generate an interpolated projection view (900) of the object (106) at the selected view angle.

2. A method according to claim 1, wherein the plurality of working projection views comprises three projection views.

3. A method according to claim 2, wherein the three projection views are respectively based on initial projection data collected in consecutive data acquisition cycles.

4. A method according to claim 1, wherein the plurality of working projection views comprises four projection views.

5. A method according to claim 1, wherein the plurality of working projection views (910, 920) consists of two projection views.

6. A method according to claim 1, wherein the object (106) is in motion during collection of the initial projection data.

7. A method according to claim 6, wherein the motion of the object (106) is cyclical motion.

8. A method according to claim 7, wherein successive cycles of the cyclical motion have a same cycle period.

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9. A method according to claim 7, wherein successive cycles of the cyclical motion each has a cycle duration within a range of variation about a nominal cycle period.

10. A method according to claim 1, wherein:

the object (106) is in cyclical motion during collection of the initial projection data; and

the determining operation comprises selecting the working projection views (910, 920) from projection views of the initial projection data based on the selected view angle and a specified phase of the cyclical motion, whereby the interpolated projection view (900) represents the object at the selected view angle and in the specified phase of the cyclical motion.

11. A method according to claim 10, wherein:

the cyclical motion comprises successive cycles of at least one of translation, rotation, and elastic deformation of the object (106); and

the specified phase corresponds to a selected translation, rotation, or elastic deformation state assumed by the object (106) in each of the successive cycles.

12. A method according to claim 1, wherein the plurality of working projection views (910, 920) consists of two projection views (910, 920) respectively based on initial projection data collected in two consecutive data acquisition cycles.

13. A method according to claim 12, wherein the specified phase is determined by a selected shape configuration repeatedly assumed by the object (106) during the cyclical change in shape configuration.

14. A method according to claim 1, wherein the initial projection data represent intensities of energetic rays transmitted through the object (106) and detected by a detector array (116).

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15. A method according to claim 1134, wherein the energetic rays comprise x-rays (104).

16. A method according to claim 14, wherein:

the detector array (116) is a multi-row detector array (2116); and

a cone beam (1104) impinges on a side of the object opposite the detector array and the energetic rays comprise rays of the cone beam (1104) transmitted through the object (106) to the detector array (2116).

17. A method according to claim 14, wherein the energetic rays are attenuated by the object (106) and the initial projection data represent intensities of the energetic rays subsequent to the attenuation.

18. A method according to claim 1, wherein the working projection views (910, 920) comprise projection views selected from the initial projection data based on contemporaneously collected timing data.

19. A method according to claim 1, wherein:

the initial projection data are collected by the detector array (116) in a cyclical scan comprising a plurality of rotational data acquisition cycles; and

the initial projection data comprise initial projection views of the object (106) collected in plural successive rotational data acquisition cycles.

20. A method according to claim 19, wherein:

the object (106) is in cyclical motion during collection of the initial projection data; and

a rotation period of the plurality of rotational data acquisition cycles is different from a cycle duration of successive cycles of the cyclical motion.

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21. A method according to claim 1, wherein the object (106) is an organ of a subject (102).

22. A method according to claim 21, wherein the organ (106) is a heart.

23. A method according to claim 12, wherein the object (106) is a human heart.

24. A method according to claim 1, wherein the interpolating operation comprises performing weighted linear interpolation between respective projection data of first and second ones of the working projection views (910, 920).

25. A method according to claim 1, wherein the interpolating operation comprises performing weighted nonlinear interpolation between respective projection data of first and second ones of the working projection views (910, 920).

26. A method according to claim 25, wherein the weighted nonlinear interpolation is weighted quadratic interpolation.

27. A method according to claim 12, wherein:

the determining operation comprises selecting first and second projection views from the initial projection data as the working projection views (910, 920), the first projection view (710) comprising projection data collected in a first data acquisition cycle and the second projection view (720) comprising projection data collected in a second data acquisition cycle subsequent to the first data acquisition cycle; and

the interpolating operation comprises performing weighted quadratic interpolation between respective projection data of the first and second projection views (910, 920).

28. A computer readable medium encoded with a program for tomographic image generation, said program comprising instructions for:

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determining a plurality of working projection views (910, 920) of an object (106) at a selected view angle based on initial projection data collected in respective different data acquisition cycles; and

interpolating between the working projection views (910, 920) to generate an interpolated projection view (900) of the object at a selected view angle.

29. A computer readable medium according to claim 28, wherein:

the object (106) is in cyclical motion during collection of the initial projection data; and

the instructions for the determining procedure comprise instructions for selecting each working projection view (910, 920) from projection views of the initial projection data based on the selected view angle and a specified phase of the cyclical motion, whereby the interpolated projection view (900) represents the object (106) at the selected view angle and in the specified phase of the cyclical motion.

30. A computer readable medium according to claim 28, wherein the plurality of working projection views (910, 920) consists of two projection views respectively based on initial projection data collected in two consecutive data acquisition cycles.

31. A computer readable medium according to claim 28, wherein the initial projection data represent intensities of energetic rays transmitted through the object (106).

32. A computer readable medium according to claim 28, wherein the working projection views (910, 920) comprise projection views selected from the initial projection data based on contemporaneously collected timing data.

33. A tomographic image generation device (130, 140), comprising:

a storage (134, 144) storing initial projection data collected from an object by a detector array; and

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a processor (132, 142) determining a plurality of working projection views (910, 920) of an object (106) at a selected view angle based on initial projection data collected in respective different data acquisition cycles, and interpolating between the working projection views (910, 920) to generate an interpolated projection view (900) of the object (106) at the selected view angle.

34. A device (130, 140) according to claim 33, wherein:

the object (106) is in cyclical motion during collection of the initial projection data; and

said processor (132) determines the working projection views (910, 920) by selecting each working projection view from projection views of the initial projection data based on the selected view angle and a specified phase of the cyclical motion, whereby the interpolated projection view (900) represents the object (106) at the selected view angle and in the specified phase of the cyclical motion.

35. A device (130, 140) according to claim 33, wherein:

the object (106) is in cyclical motion during collection of the initial projection data; and

the plurality of working projection views (910, 920) consists of two projection views respectively based on initial projection data collected in two consecutive data acquisition cycles.

36. A device (130, 140) according to claim 33, wherein the projection data are collected from energetic rays transmitted through the object (106).

37. A device (130, 140) according to claim 33, wherein the working projection views (910, 920) comprise projection views selected from the initial projection data based on contemporaneously collected timing data.

38. A tomographic image generation system (100), comprising:

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a detector array (116) generating initial projection data for an object (106); and

a computer (130, 140) comprising a processor (132, 142) determining a plurality of working projection views (910, 920) of an object (106) at a selected view angle based on initial projection data collected in respective different data acquisition cycles, and interpolating between the working projection views (910, 920) to generate an interpolated projection view (900) of the object (106) at the selected view angle.

39. A system (100) according to claim 38, wherein:

the object (106) is in cyclical motion during collection of the initial projection data; and

the processor (132, 142) determines the working projection views (910, 920) by selecting each working projection view from projection views of the initial projection data based on the selected view angle and a specified phase of the cyclical motion, whereby the interpolated projection view (900) represents the object (106) at the selected view angle and in the specified phase of the cyclical motion.

40. A system (100) according to claim 38, wherein the plurality of working projection views (910, 920) consists of two projection views respectively based on initial projection data collected in two consecutive data acquisition cycles.

41. A system (100) according to claim 38, wherein the initial projection data represent intensities of energetic rays transmitted through the object (106).

42. A system (100) according to claim 38, wherein the working projection views comprise projection views selected from the initial projection data based on contemporaneously collected timing data.

43. A projection data processing method, comprising:

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tagging projection views (910, 920) representing an object (106) in motion with tags indicating respective phases of the motion and respective axial locations for the projection views (910, 920);

determining the tagged projection views (910, 920) representing the object at respective axial locations within a collimation distance from a selected axial location;

determining separation values representing phase separations between the phases of the determined projection views (910, 920) and a selected phase of the motion;

determining projection view subsets from the determined projection views, each projection view subset comprising plural projection views tagged with respective different phases of the motion at each of plural view angles covering a corresponding reconstruction range;

determining for each view angle of each projection view subset a minimum of the separation values of the projection views of the subset at the view angle;

computing a separation measure for each projection view subset by summing the minimum separation values of the projection view subset;

selecting from the determined projection view subsets a subset having a minimum separation measure of the computed separation measures;

successively selecting the view angles of the selected projection view subset; and

interpolating between the plural projection views of the selected projection view subset at each selected view angle to generate an interpolated projection view (900) of the object (106) at the selected axial position and the selected view angle.

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44. A method according to claim 43, wherein the motion of the object (106) is cyclical motion.

45. A method according to claim 43, wherein the selected projection view subset comprises for each view angle thereof at least three projection views at respective different phases of the motion.

46. A method according to claim 44, wherein:

the selected projection view subset comprises for each view angle thereof and each of a predetermined number of different phases of the motion a plurality of projection views representing the object at respective axial positions within the collimation distance from the selected axial position; and

the interpolating operation comprises, for each of the view angles and each of the predetermined number of different phases, interpolating between the plurality of projection views representing the object at respective axial locations.

47. A tomographic image generation method, comprising:

determining a plurality of working projection views (910, 920) of an object (106) in cyclical motion based on initial projection data collected from the object (106), the working projection views (910, 920) being based on selected initial projection data collected in respective different data acquisition cycles; and

interpolating between the working projection views (910, 920) to generate an interpolated projection view (900) representing the object (106) at the selected view angle and at a specified phase of the cyclical motion.

48. A method according to claim 47, wherein the plurality of working projection views (910, 920) consists of two projection views.

49. A method according to claim 47, wherein the cyclical motion comprises successive cycles of motion each having a cycle duration within a range of variation about a nominal cycle duration.

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50. A method according to claim 47, wherein the cyclical motion comprises successive cycles of periodic motion.

51. A method according to claim 47, wherein the object (106) is a heart within a living subject (102).

52. A method according to claim 51, wherein the cyclical motion consists of successive repetitions of a cardiac cycle of the heart (106) and the specified phase is a specified phase of the cardiac cycle.

53. A method according to claim 47, wherein the working projection views (910, 920) comprise projection views selected from the initial projection data based on contemporaneously collected timing data.

54. A method according to claim 47, wherein:

the cyclical motion comprises cyclical elastic deformation of the object (106); and

the specified phase corresponds to a selected shape repeatedly assumed by the object (106) during the cyclical elastic deformation.

55. A method according to claim 47, further comprising collecting quantitative data over plural successive cycles of the cyclical motion, the quantitative data representing a physical property of the object (106) varying synchronously in time with the cyclical motion of the object (106).

56. A method according to claim 55, wherein:

the object (106) is a heart within a living subject (102) and the cyclical motion comprises successive repetitions of a cardiac cycle of the heart (106); and

the quantitative data comprises electrocardiogram data representing an electrical cycle of the heart (106) and the specified phase of the cyclical motion coincides with a selected wave of the electrical cycle.

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57. A method according to claim 56, wherein the selected wave is an R-wave of the electrocardiogram data and the specified phase occurs at a selected time delay after the R-wave.

58. A method according to claim 47, wherein the initial projection data are determined from energetic rays (104) transmitted through the object (106).

59. A method according to claim 58, wherein the initial projection data represent attenuation of the energetic rays (104) by the object (106).

60. A method according to claim 47, wherein the determining operation comprises selecting the working projection views (910, 920) from a plurality of first projection views of the initial projection data.

61. A method according to claim 47, wherein:

the initial projection data are collected in a helical tomographic scan of the object (106) by a multi-row detector array (2116) and comprise plural rows of projection data for each of plural rotational data acquisition cycles of the helical tomographic scan; and

the determining operation comprises computing working projection data for each working projection view (910, 920) based on the initial projection data.

62. A method according to claim 61, further comprising selecting an axial position of the helical scan for the interpolated projection view 900, and wherein for each working projection view (910, 920), the determining operation comprises:

selecting a rotational data acquisition cycle of the helical tomographic scan corresponding to the specified phase of the cyclical motion,

selecting from the plural rows of projection data for the selected rotational data acquisition cycle first and second rows of data corresponding to first and second rows of the multi-row detector array (2116) nearest to the selected axial position during the selected rotational data acquisition cycle, and

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interpolating between the respective projection data of the first and second rows of data to generate the working projection data for the working projection view (900).

63. A method according to claim 47, wherein:

the initial projection data are collected for the object (106) over a plurality of rotational data acquisition cycles using a rotation period different from a cycle duration for a cycle of the cyclical motion; and

first and second ones of the working projection views (910, 920) represent the object (106) in two consecutive rotational data acquisition cycles.

64. A method according to claim 63, wherein the object (106) is an organ of a living subject (102).

65. A method according to claim 47, further comprising:

performing the determining operation successively to determine a succession of pluralities of working projection views (910, 920); and

performing the interpolating operation successively for the succession of pluralities of working projection views (910, 920) to generate a succession of interpolated projection views (900); and

generating a tomographic image of the object (106) by image reconstruction using the projection views of the succession of pluralities of working projection views (910, 920) and the projection views of the succession of interpolated projection views (900).

66. A tomographic image generation apparatus, comprising:

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a storage (134, 144) storing initial projection data for an object in cyclical motion, the initial projection data relating to a specified phase of the cyclical motion and a selected view angle; and

a processor (132, 142) determining a plurality of working projection views (910, 920) of an object (106) in cyclical motion based on initial projection data collected from the object (106), the working projection views (910, 920) being based on selected initial projection data collected in respective different data acquisition cycles, and interpolating between the working projection views (910, 920) to generate an interpolated projection view (900) representing the object (106) at the selected view angle and at a specified phase of the cyclical motion.

67. A tomographic image generation system (100), comprising:

an x-ray source (1114) generating a cone beam (1104) of x-rays to impinge upon a subject (1122);

a multi-row detector array (2116) receiving x-rays transmitted through the subject (1122) from said x-ray source (1114) and generating initial projection data from the received x-rays, at least a portion of the subject (1122) being in cyclical motion and the initial projection data corresponding to a specified phase of the cyclical motion and a selected view angle; and

a computer (130, 140) determining a plurality of working projection views of the at least a portion in cyclical motion based on initial projection data collected from the subject (1122), the working projection views (910, 920) being based on selected initial projection data collected in respective different data acquisition cycles, said computer (130, 140) interpolating between the working projection views (910, 920) to generate an interpolated projection view (900) representing the at least a portion of the subject (1122) at the selected view angle and at a specified phase of the cyclical motion.

68. A tomographic image generation method, comprising:

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determining separation measures for projection data covering corresponding reconstruction ranges and representing an imaged object over plural data acquisition cycles; and

reconstructing a tomographic image of the object based on a portion of the projection data covering a reconstruction range selected responsive to a determination that the corresponding separation measure satisfies a predetermined selection criterion.

69. A method according to claim 68, wherein determining the separation measures comprises:

calculating a separation value for each projection view comprised in the projection data; and

calculating each separation measure based on the separation values of the projection views having view angles in the corresponding reconstruction range.

70. A method according to claim 68, further comprising:

determining a minimum separation measure from the separation measures of the reconstruction ranges; and

selecting the reconstruction range corresponding to the minimum separation measure as the selected reconstruction range.

71. A method according to claim 68, further comprising:

collecting the projection data over the plural data acquisition cycles; and

collecting timing information contemporaneously with collecting the projection data, the timing information representing a time sequence of a dynamic behavior of the object during collection of the projection data;

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and wherein the separation measures are determined based on the contemporaneous timing information.

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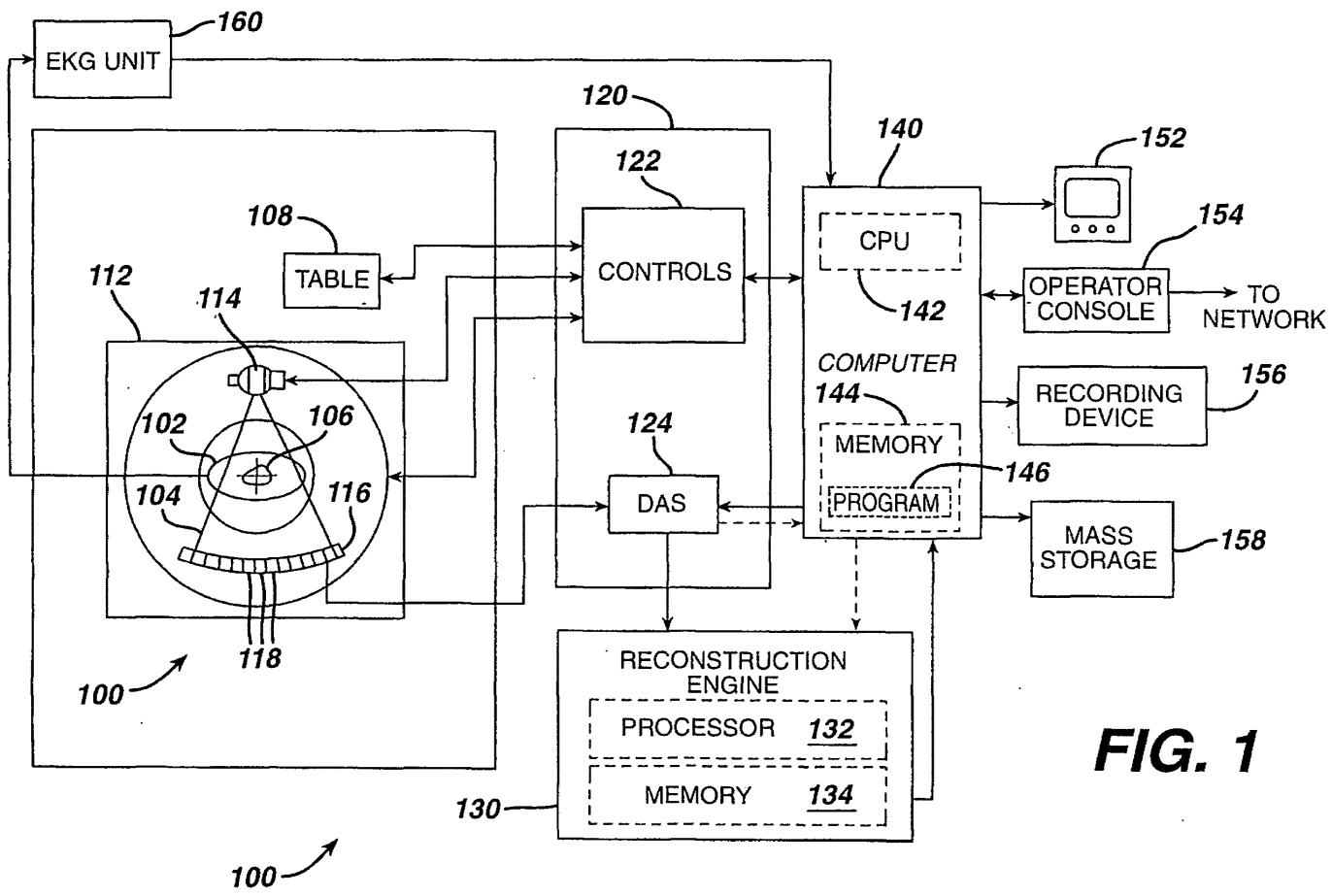

EKG UNIT
160
120
122
140
152
108
TABLE
CONTROLS
CPU
154
112
114
142
OPERATOR CONSOLE
TO NETWORK
COMPUTER
144
156
RECORDING DEVICE
102
106
124
MEMORY
146
104
116
DAS
PROGRAM
MASS STORAGE
158
118
100
RECONSTRUCTION ENGINE
PROCESSOR 132
MEMORY 134
130
100

FIG. 1

FIG. 2

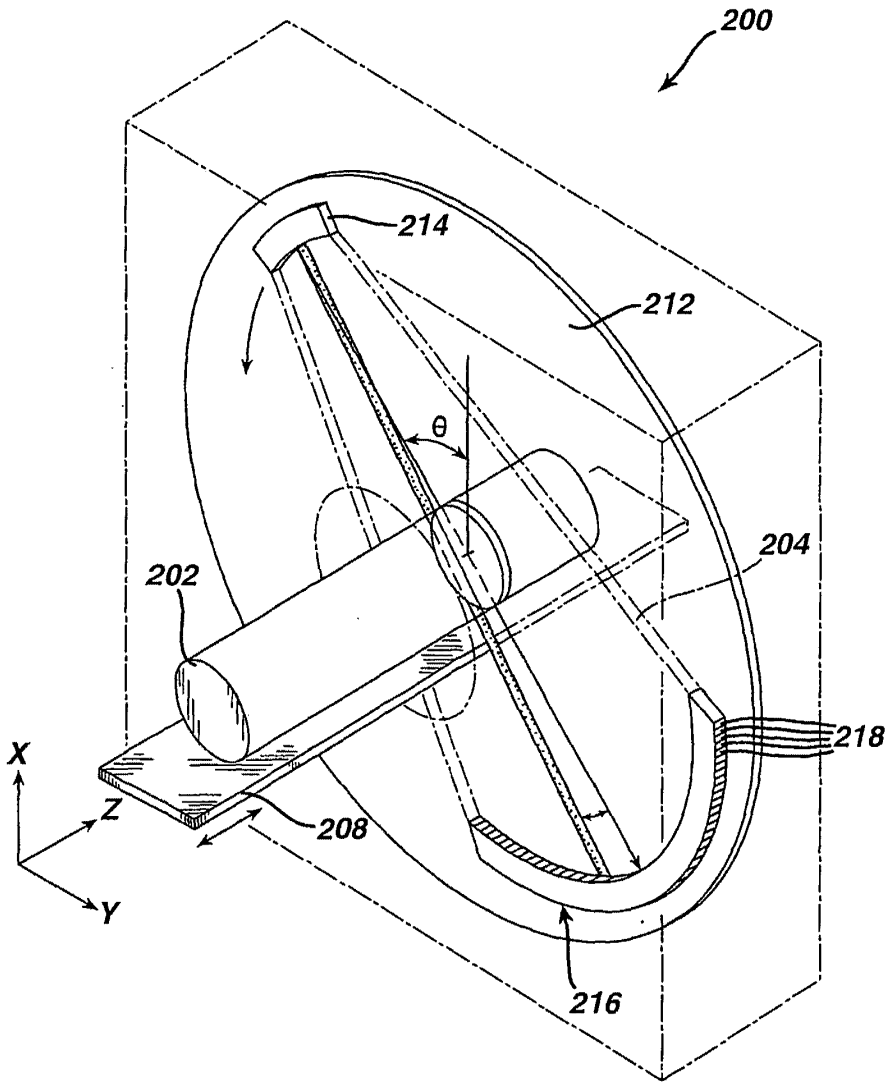


FIG. 3

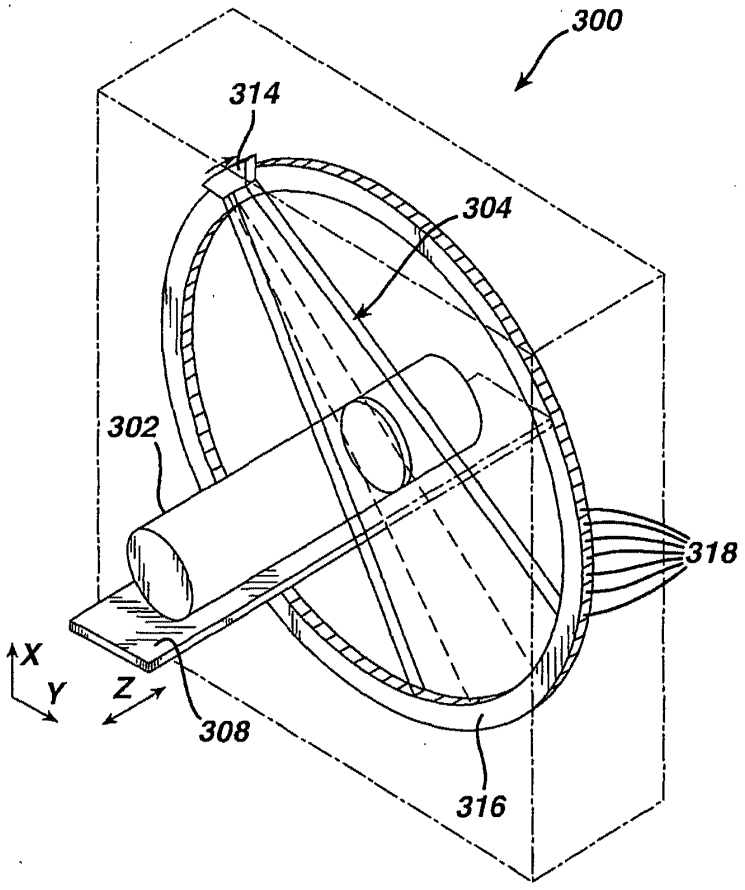


FIG. 4

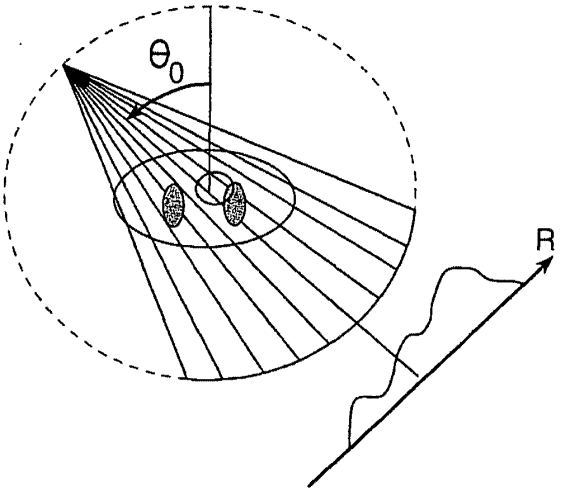
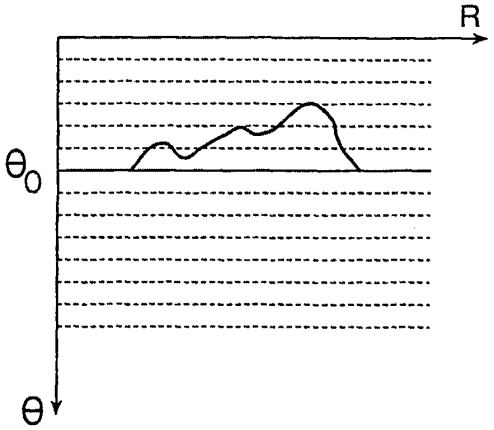


FIG. 5



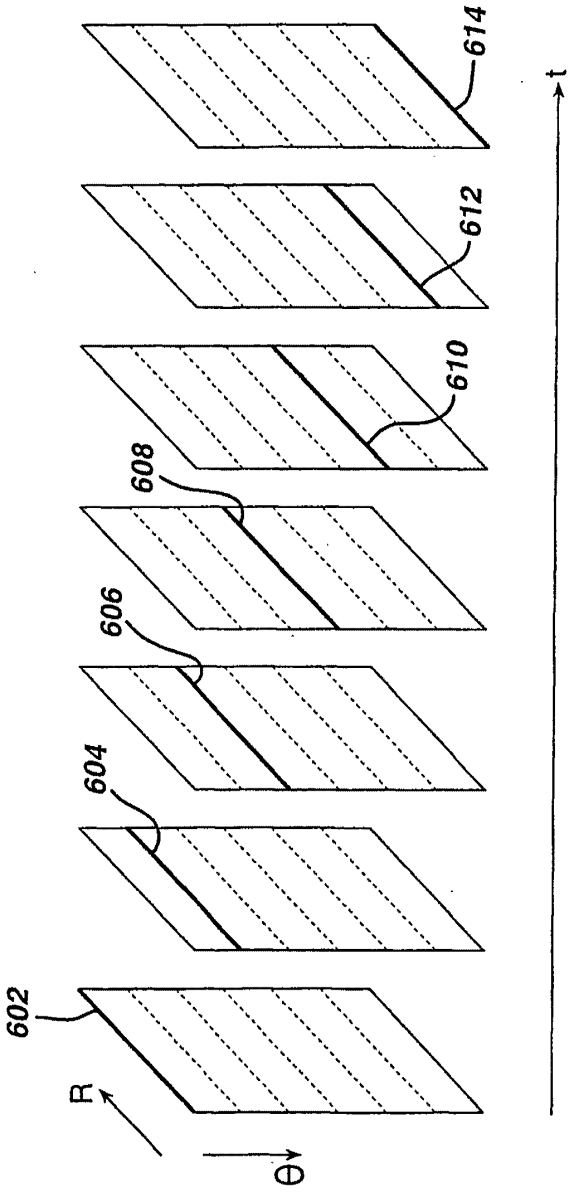


FIG. 6

FIG. 7

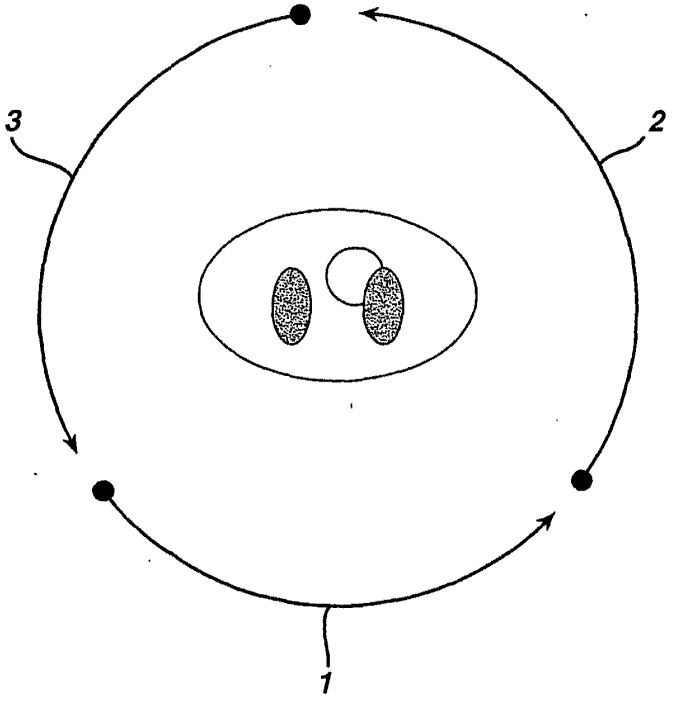


FIG. 8

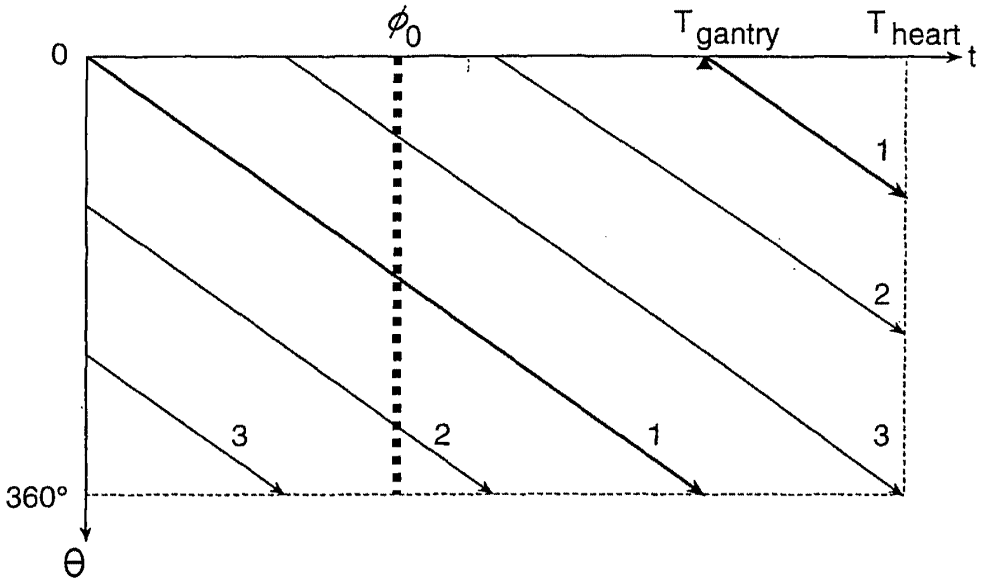

ϕ_0
T_{gantry}
T_{heart}
0
t
1
2
3
2
1
3
360°
θ

FIG. 9

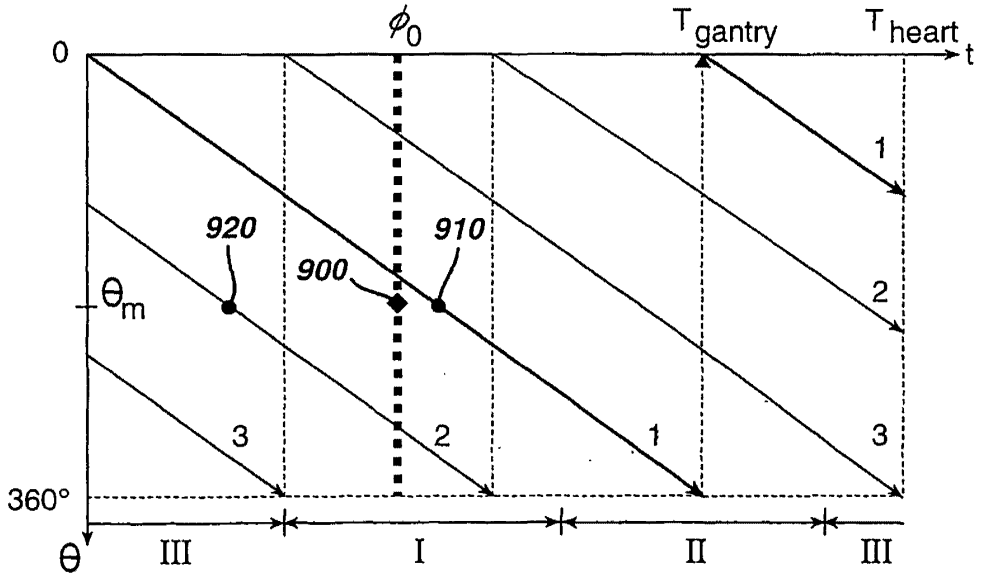

ϕ_0
T_{gantry}
T_{heart}
0
t
1
2
3
920
910
900
θ_m
2
1
3
360°
θ
III
I
II
III

FIG. 10

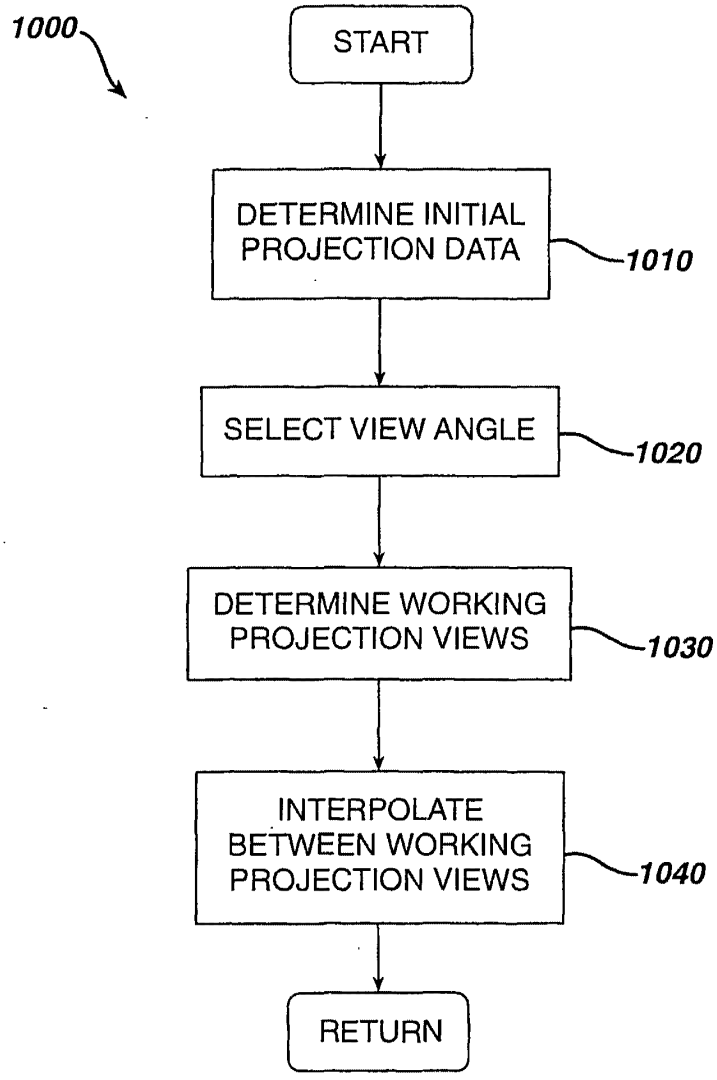

1000
START
DETERMINE INITIAL PROJECTION DATA
1010
SELECT VIEW ANGLE
1020
DETERMINE WORKING PROJECTION VIEWS
1030
INTERPOLATE BETWEEN WORKING PROJECTION VIEWS
1040
RETURN

FIG. 11

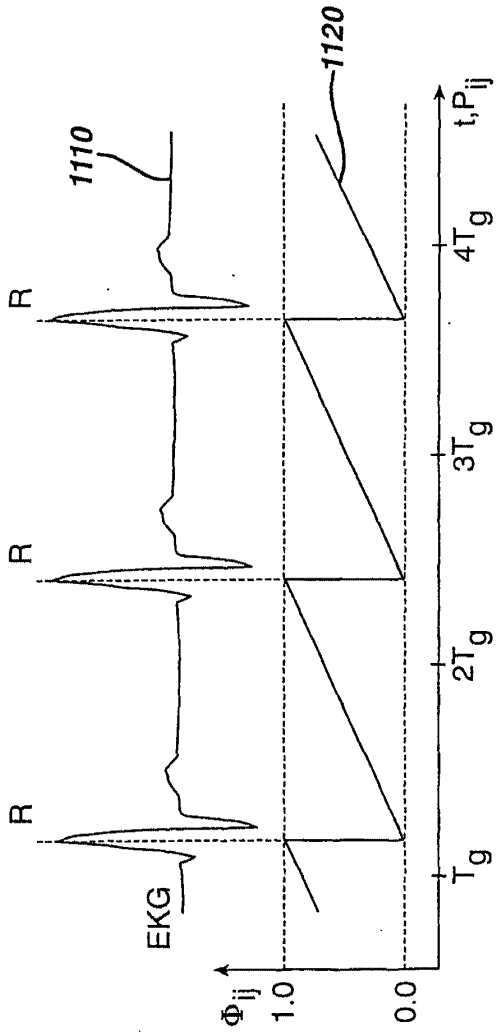


FIG. 12

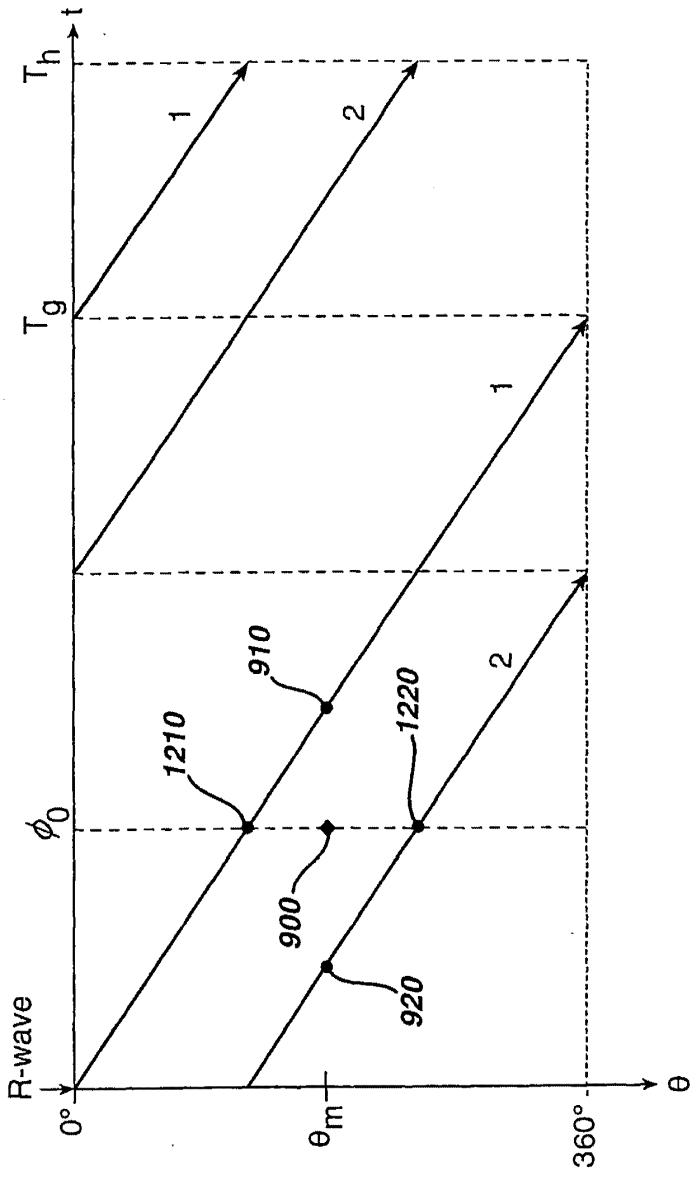


FIG. 13

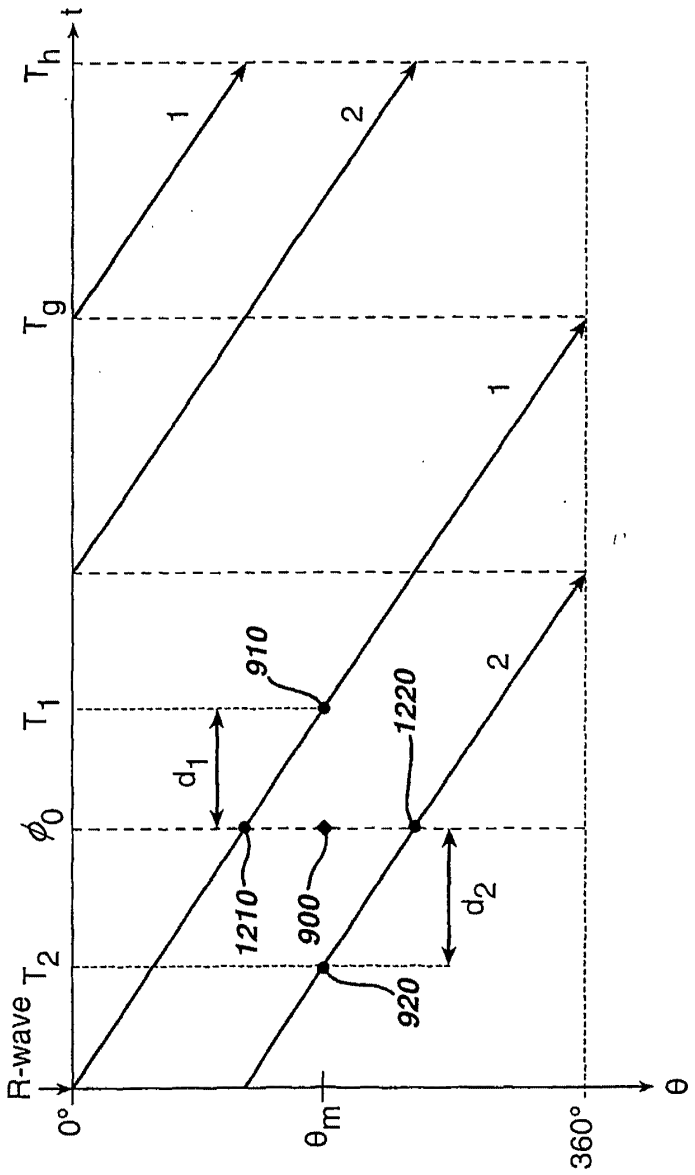

t
T_h
T_g
T_1
ϕ_0
T_2
R-wave
0°
θ_m
360°
θ
1
2
1
2
910
1220
1210
900
920
d_1
d_2

FIG. 14

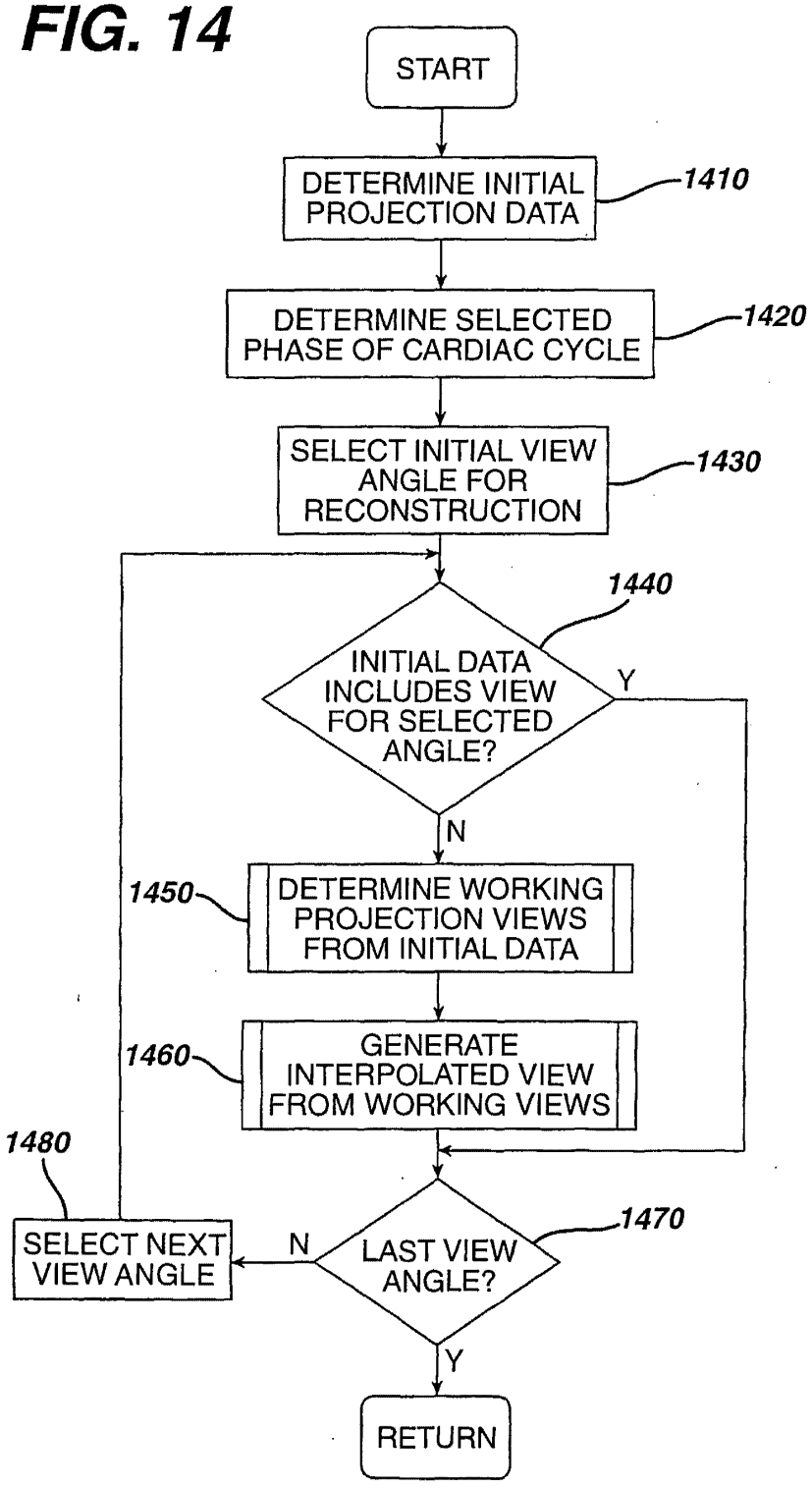

START
DETERMINE INITIAL PROJECTION DATA
1410
DETERMINE SELECTED PHASE OF CARDIAC CYCLE
1420
SELECT INITIAL VIEW ANGLE FOR RECONSTRUCTION
1430
1440
INITIAL DATA INCLUDES VIEW FOR SELECTED ANGLE?
Y
N
1450
DETERMINE WORKING PROJECTION VIEWS FROM INITIAL DATA
1460
GENERATE INTERPOLATED VIEW FROM WORKING VIEWS
1480
SELECT NEXT VIEW ANGLE
N
LAST VIEW ANGLE?
1470
Y
RETURN

FIG. 15

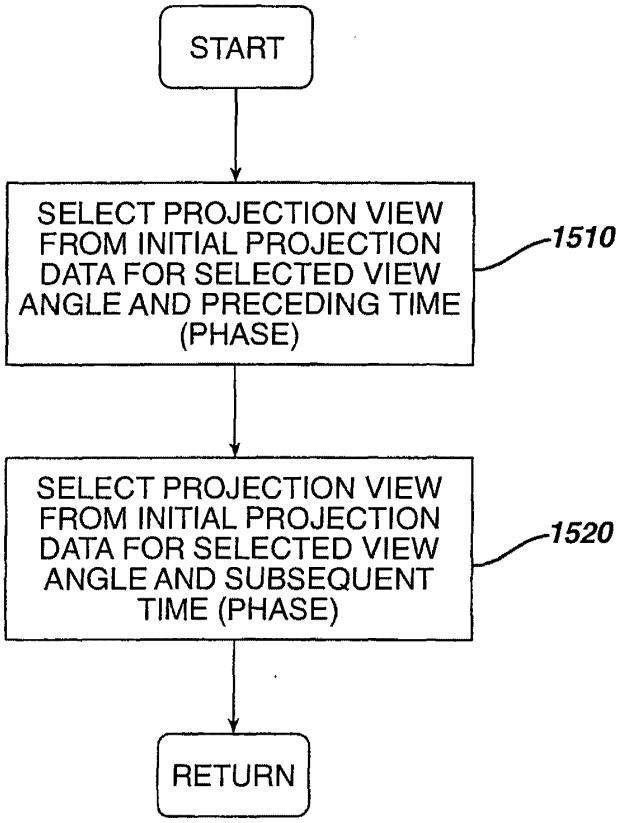

START
SELECT PROJECTION VIEW FROM INITIAL PROJECTION DATA FOR SELECTED VIEW ANGLE AND PRECEDING TIME (PHASE)
1510
SELECT PROJECTION VIEW FROM INITIAL PROJECTION DATA FOR SELECTED VIEW ANGLE AND SUBSEQUENT TIME (PHASE)
1520
RETURN

FIG. 16

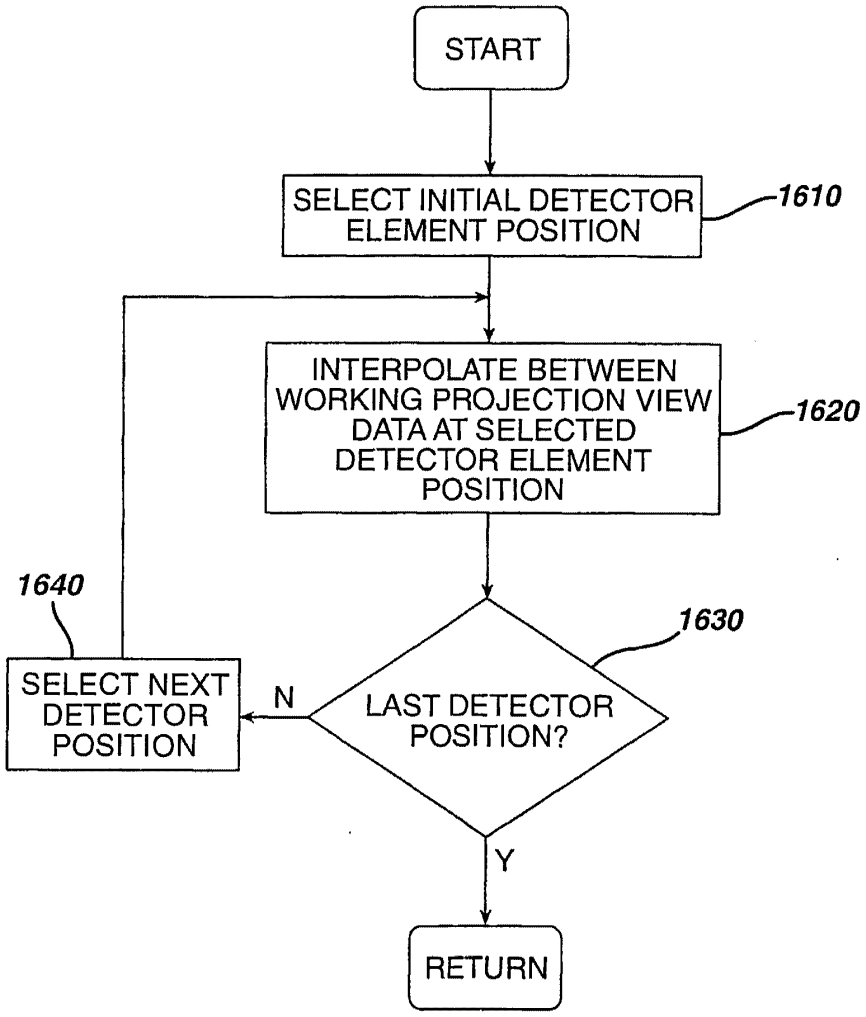

START
SELECT INITIAL DETECTOR ELEMENT POSITION
1610
INTERPOLATE BETWEEN WORKING PROJECTION VIEW DATA AT SELECTED DETECTOR ELEMENT POSITION
1620
1630
LAST DETECTOR POSITION?
N
Y
1640
SELECT NEXT DETECTOR POSITION
RETURN

FIG. 17

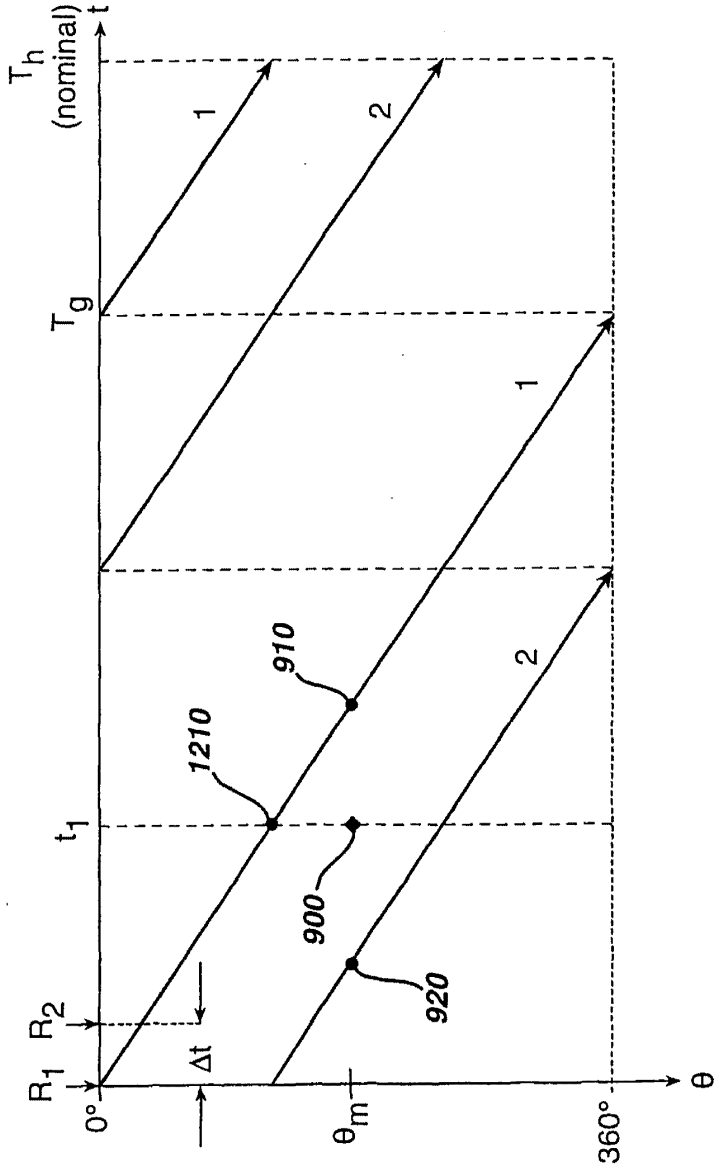


FIG. 18

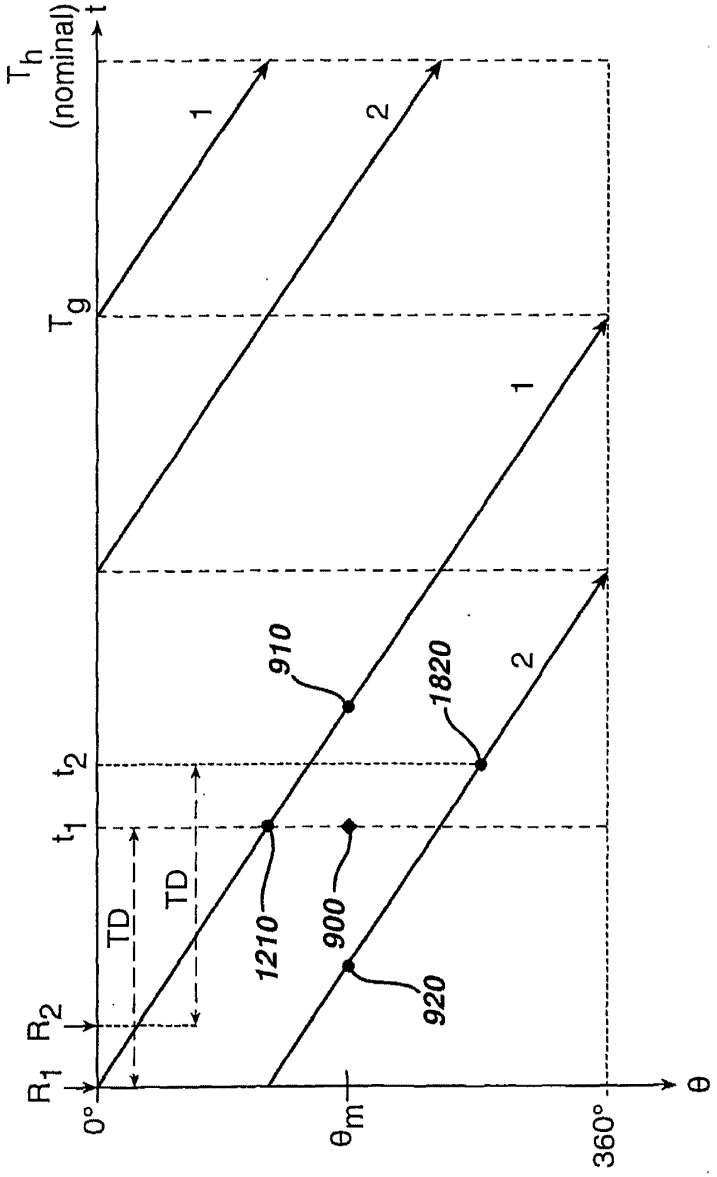

T_h (nominal)
t
T_g
1
2
1
2
910
1820
t_2
t_1
TD
TD
1210
900
920
R_2
R_1
0°
θ_m
360°
θ

FIG. 19

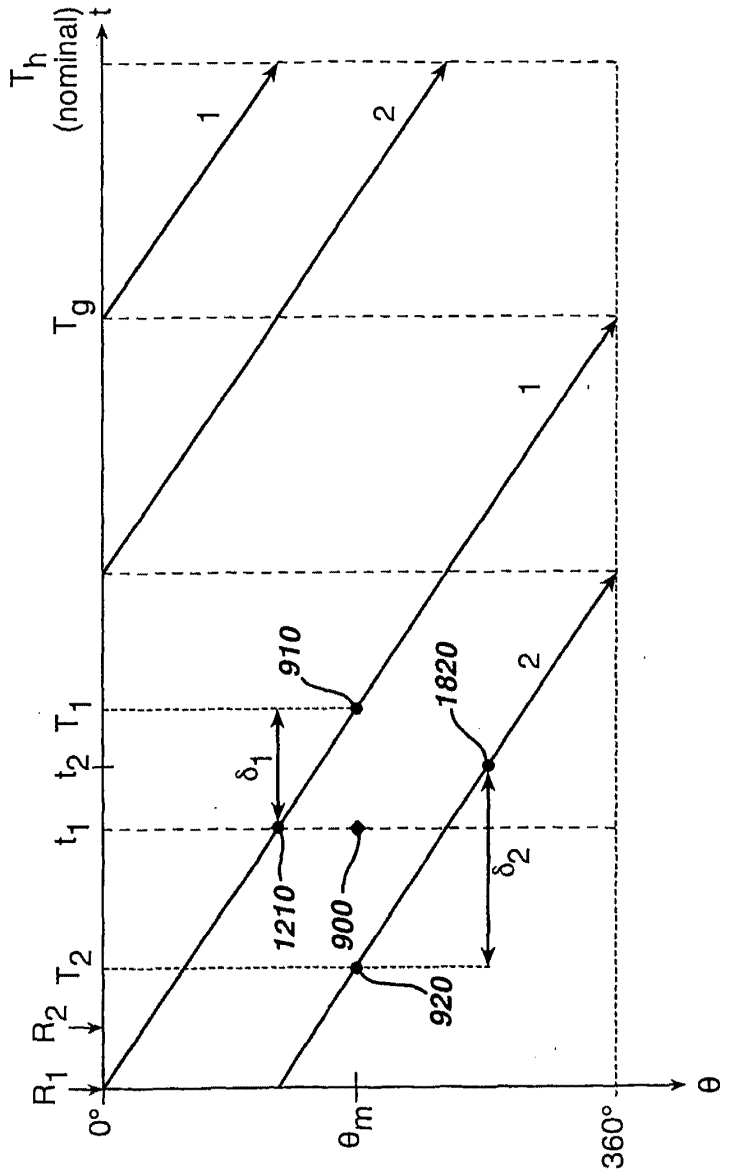

T_h (nominal)
t
T_g
1
2
1
2
910
1820
T_1
t_2
t_1
T_2
R_2
R_1
δ_1
δ_2
1210
900
920
0°
θ_m
360°
θ

FIG. 20

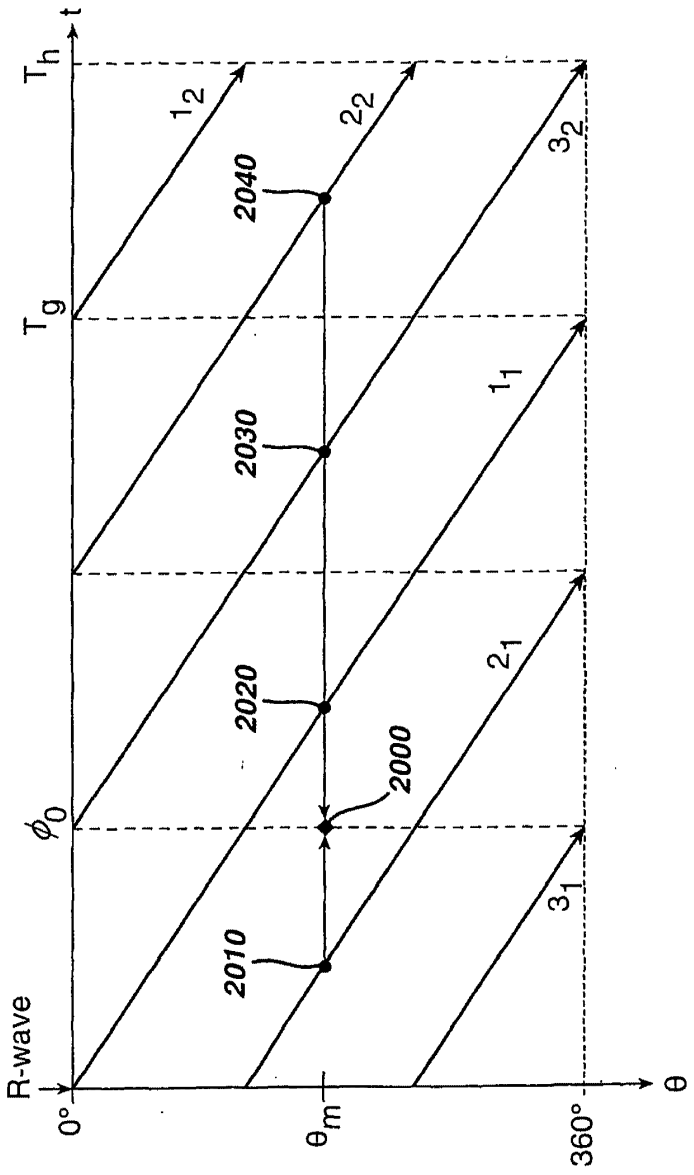

t
T_h
T_g
ϕ_0
R-wave
0°
θ_m
360°
θ
1_2
2_2
3_2
1_1
2_1
3_1
2040
2030
2020
2000
2010

FIG. 21

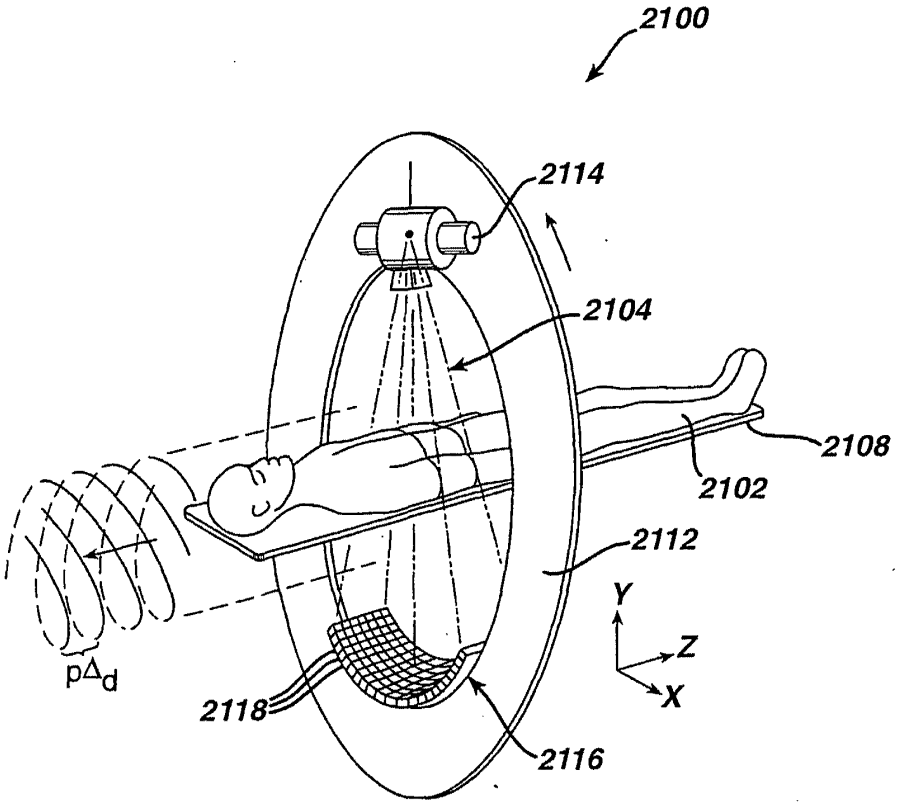


FIG. 22

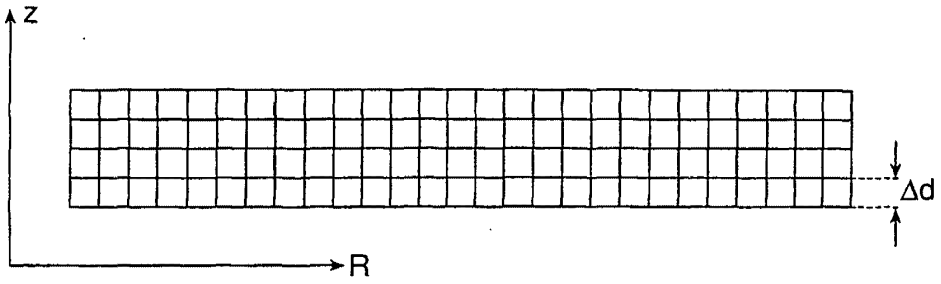

z
Δd
R

FIG. 23

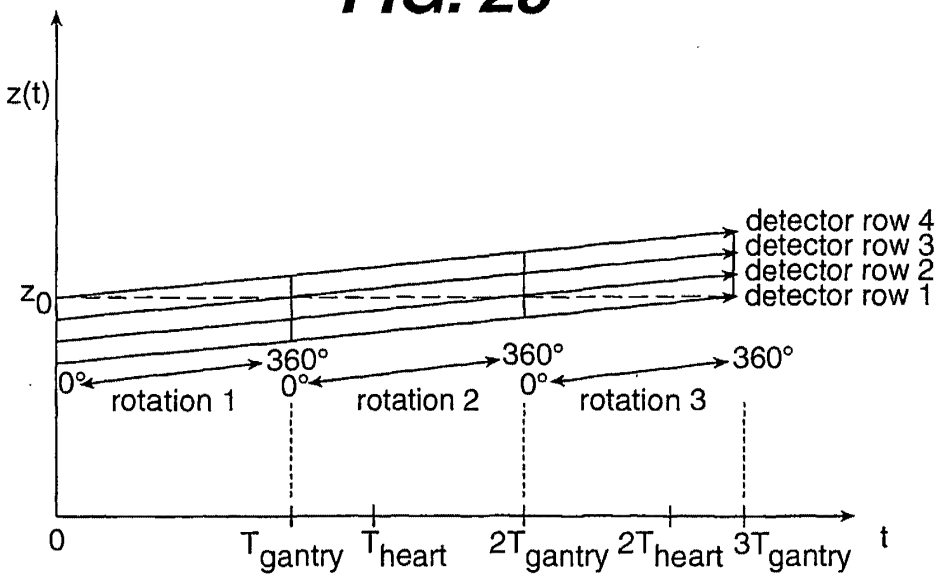

z(t)
z0
detector row 4
detector row 3
detector row 2
detector row 1
0°
360°
rotation 1
0°
360°
rotation 2
0°
360°
rotation 3
0
Tgantry
Theart
2Tgantry
2Theart
3Tgantry
t

FIG. 24

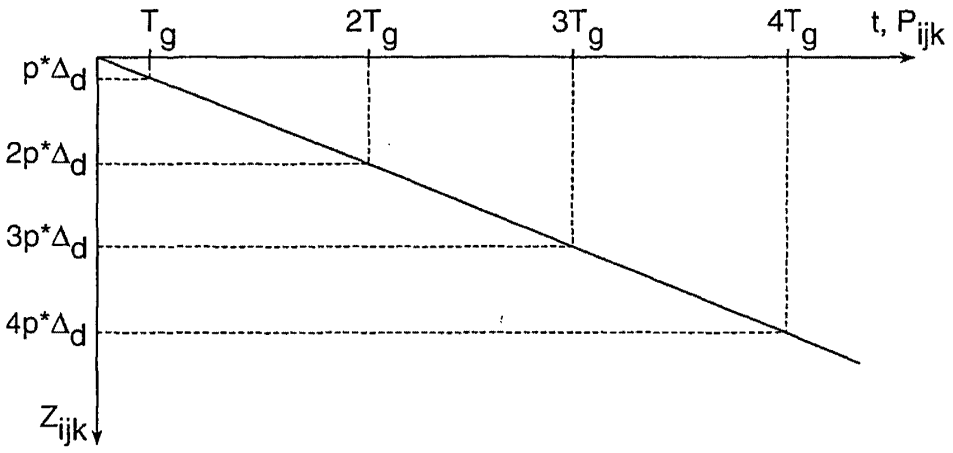

T_g
$2T_g$
$3T_g$
$4T_g$
t, P_{ijk}
$p^*\Delta_d$
$2p^*\Delta_d$
$3p^*\Delta_d$
$4p^*\Delta_d$
Z_{ijk}

FIG. 25

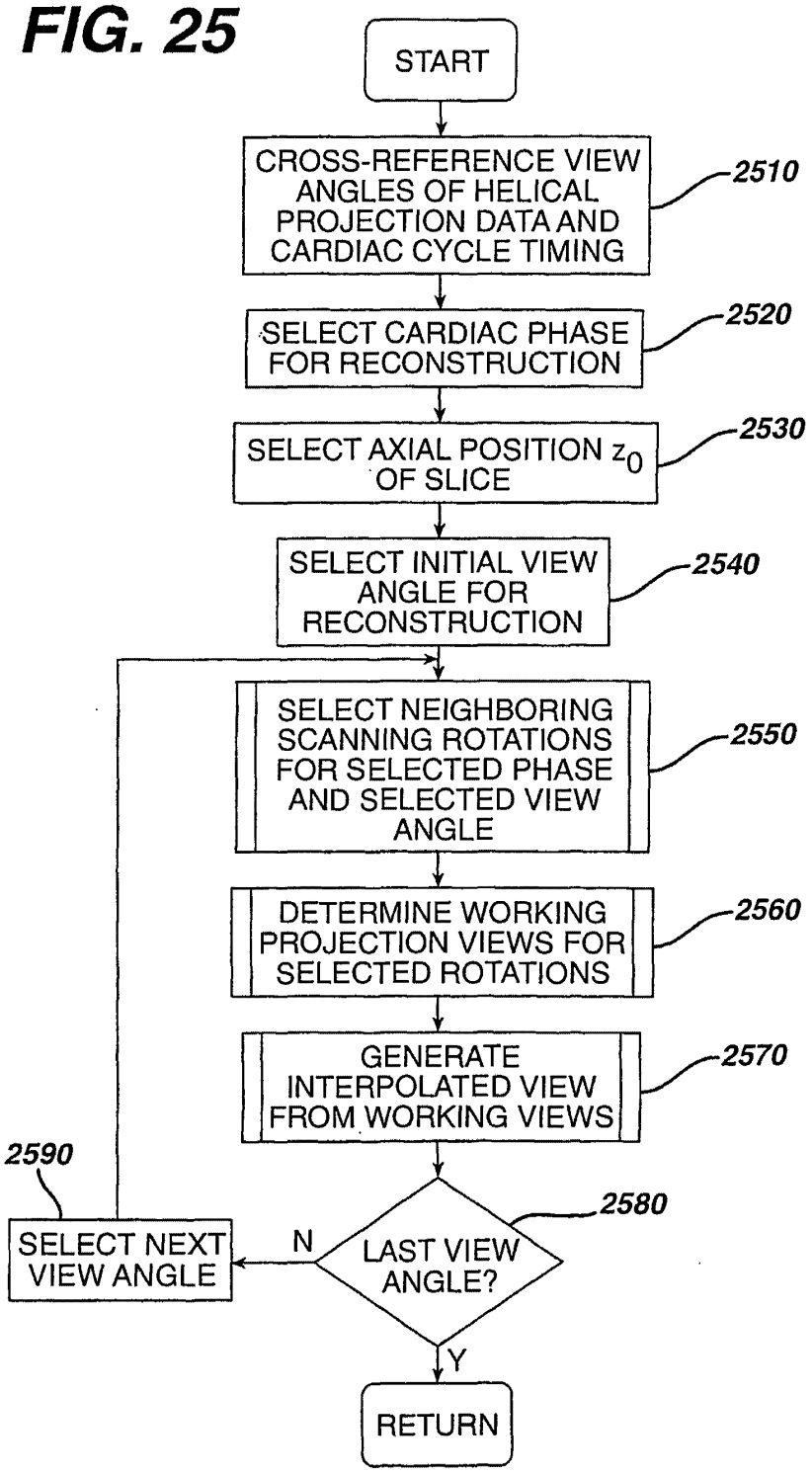

START
CROSS-REFERENCE VIEW ANGLES OF HELICAL PROJECTION DATA AND CARDIAC CYCLE TIMING
2510
SELECT CARDIAC PHASE FOR RECONSTRUCTION
2520
SELECT AXIAL POSITION z_0 OF SLICE
2530
SELECT INITIAL VIEW ANGLE FOR RECONSTRUCTION
2540
SELECT NEIGHBORING SCANNING ROTATIONS FOR SELECTED PHASE AND SELECTED VIEW ANGLE
2550
DETERMINE WORKING PROJECTION VIEWS FOR SELECTED ROTATIONS
2560
GENERATE INTERPOLATED VIEW FROM WORKING VIEWS
2570
LAST VIEW ANGLE?
2580
N
SELECT NEXT VIEW ANGLE
2590
Y
RETURN

FIG. 26

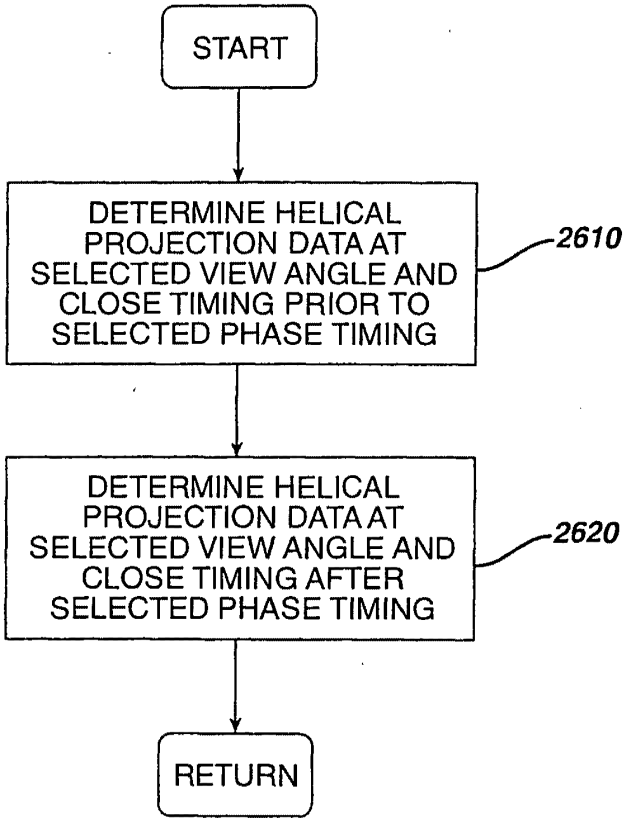

START
DETERMINE HELICAL PROJECTION DATA AT SELECTED VIEW ANGLE AND CLOSE TIMING PRIOR TO SELECTED PHASE TIMING
2610
DETERMINE HELICAL PROJECTION DATA AT SELECTED VIEW ANGLE AND CLOSE TIMING AFTER SELECTED PHASE TIMING
2620
RETURN

FIG. 27

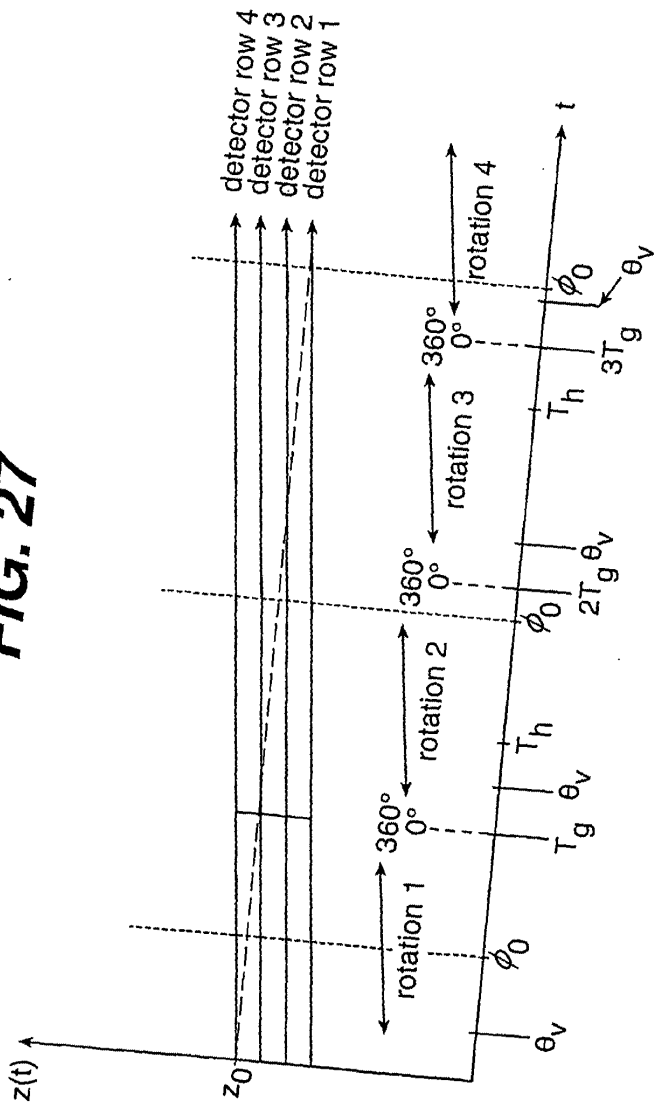

detector row 4
detector row 3
detector row 2
detector row 1
t
z(t)
z_0
rotation 1
rotation 2
rotation 3
rotation 4
360°
0°
ϕ_0
θ_v
T_g
T_h
$2T_g$
$3T_g$

FIG. 28

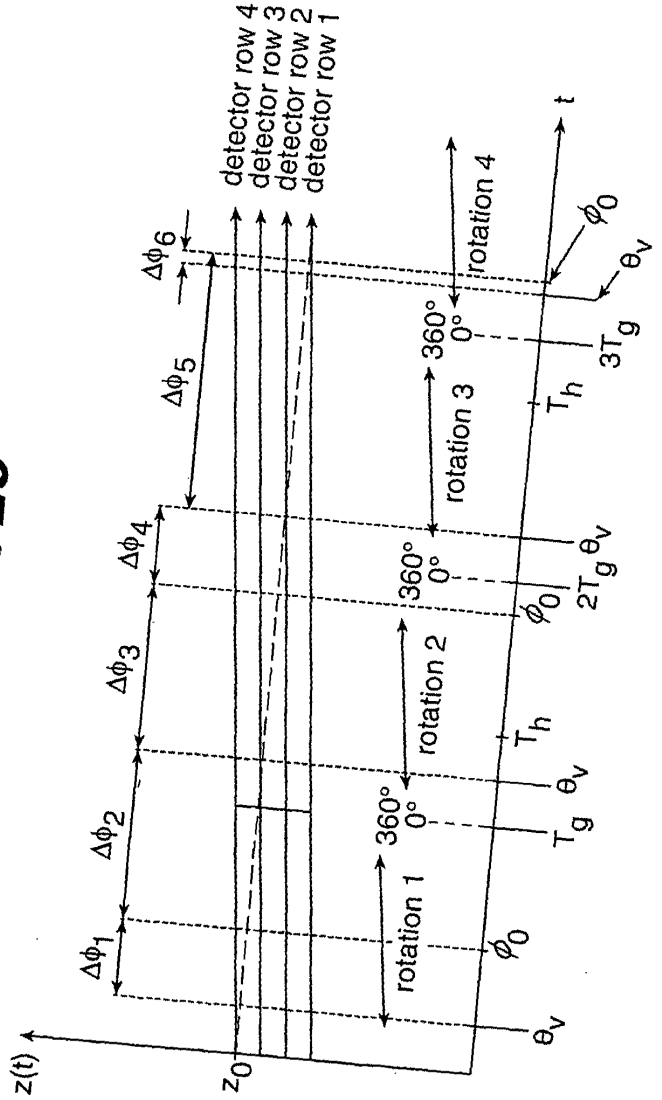

detector row 4
detector row 3
detector row 2
detector row 1
t
z(t)
z_0
$\Delta\phi_6$
$\Delta\phi_5$
$\Delta\phi_4$
$\Delta\phi_3$
$\Delta\phi_2$
$\Delta\phi_1$
rotation 4
rotation 3
rotation 2
rotation 1
360°
0°
ϕ_0
θ_v
$3T_g$
T_h
$2T_g$
T_h
T_g

FIG. 29

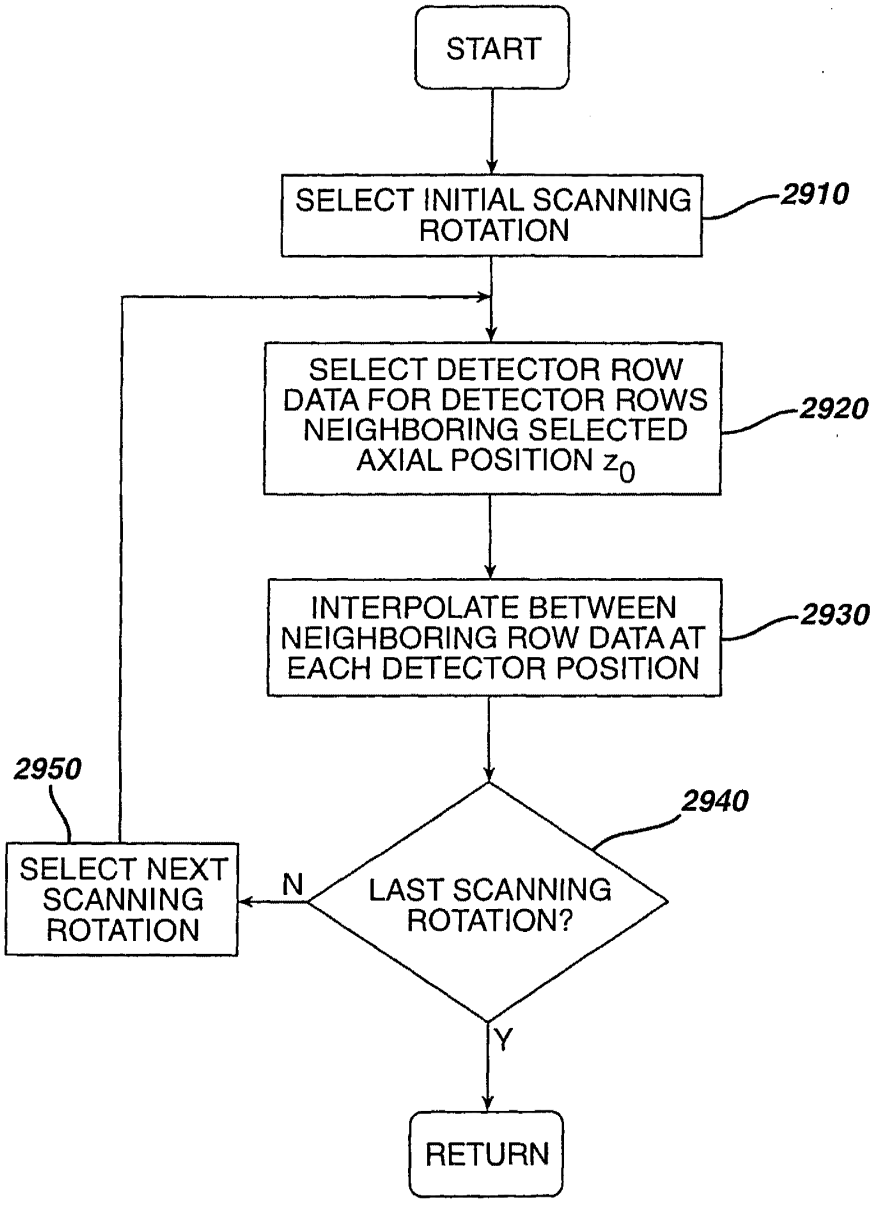

START
SELECT INITIAL SCANNING ROTATION
2910
SELECT DETECTOR ROW DATA FOR DETECTOR ROWS NEIGHBORING SELECTED AXIAL POSITION z_0
2920
INTERPOLATE BETWEEN NEIGHBORING ROW DATA AT EACH DETECTOR POSITION
2930
2940
LAST SCANNING ROTATION?
N
Y
2950
SELECT NEXT SCANNING ROTATION
RETURN

FIG. 30

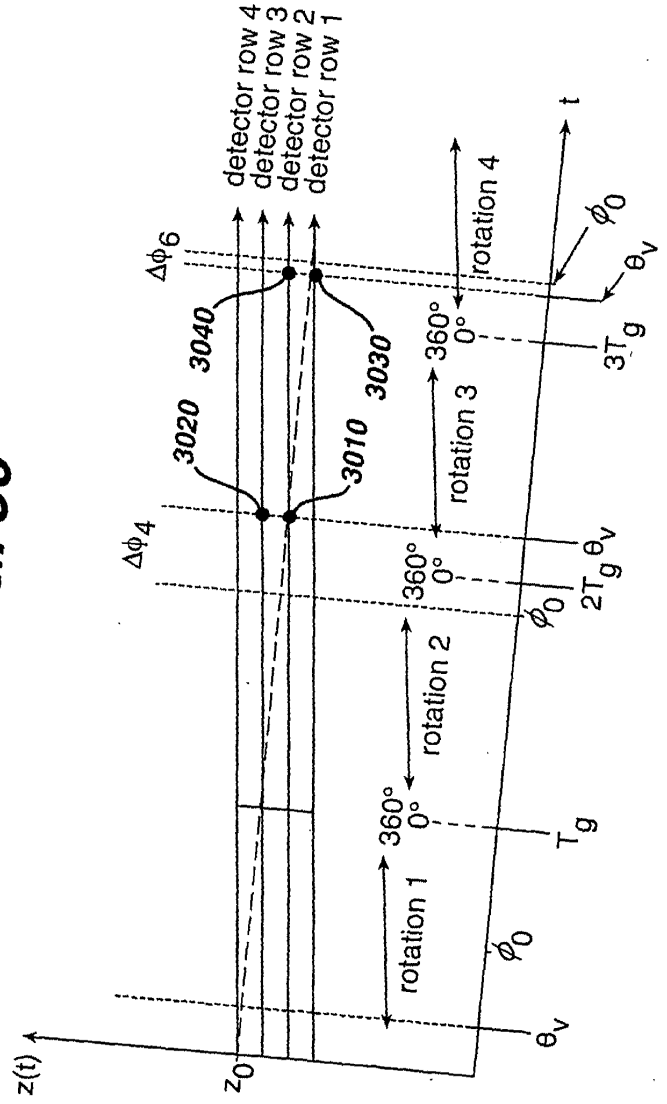

detector row 4
detector row 3
detector row 2
detector row 1
t
$\Delta\phi_6$
3040
3030
3020
3010
$\Delta\phi_4$
rotation 4
rotation 3
rotation 2
rotation 1
360°
0°
ϕ_0
θ_v
$3T_g$
$2T_g$
T_g
z(t)
z_0

FIG. 31

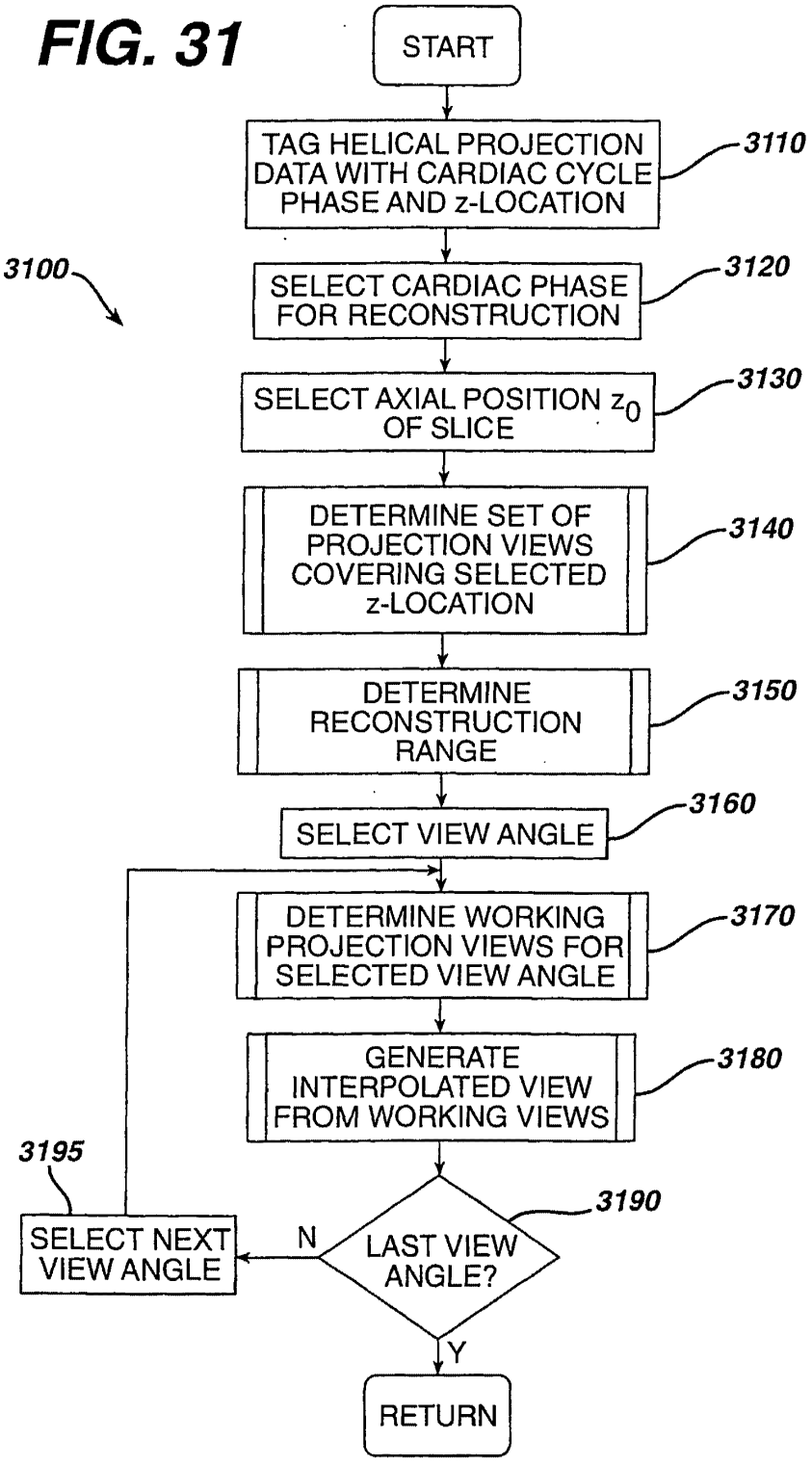

START
TAG HELICAL PROJECTION DATA WITH CARDIAC CYCLE PHASE AND z-LOCATION
3110
3100
SELECT CARDIAC PHASE FOR RECONSTRUCTION
3120
SELECT AXIAL POSITION z_0 OF SLICE
3130
DETERMINE SET OF PROJECTION VIEWS COVERING SELECTED z-LOCATION
3140
DETERMINE RECONSTRUCTION RANGE
3150
SELECT VIEW ANGLE
3160
DETERMINE WORKING PROJECTION VIEWS FOR SELECTED VIEW ANGLE
3170
GENERATE INTERPOLATED VIEW FROM WORKING VIEWS
3180
3195
SELECT NEXT VIEW ANGLE
N
LAST VIEW ANGLE?
3190
Y
RETURN

FIG. 32

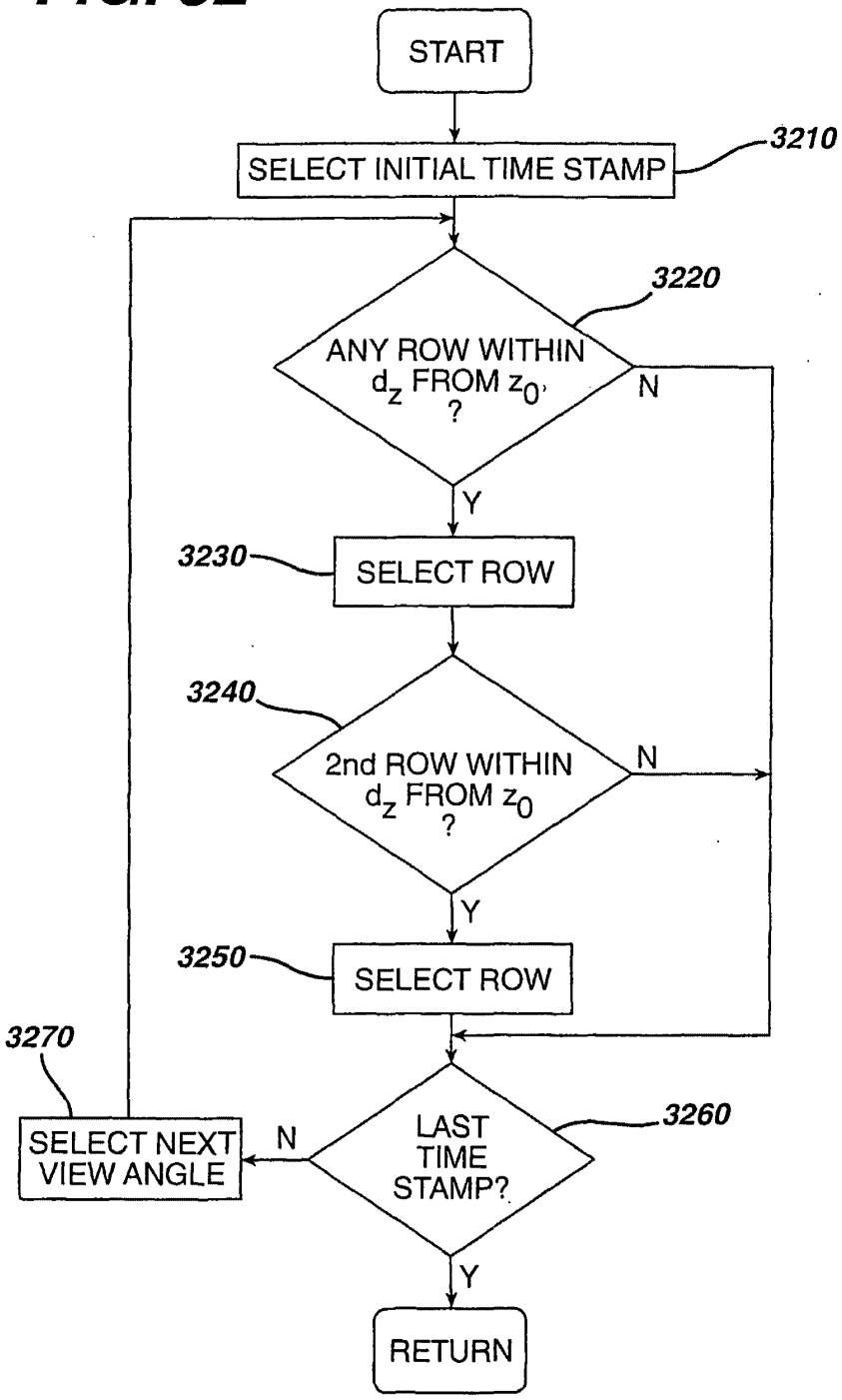

START
SELECT INITIAL TIME STAMP
3210
ANY ROW WITHIN d_z FROM z_0 ?
3220
N
Y
3230
SELECT ROW
2nd ROW WITHIN d_z FROM z_0 ?
3240
N
Y
3250
SELECT ROW
3270
SELECT NEXT VIEW ANGLE
N
LAST TIME STAMP?
3260
Y
RETURN

FIG. 33

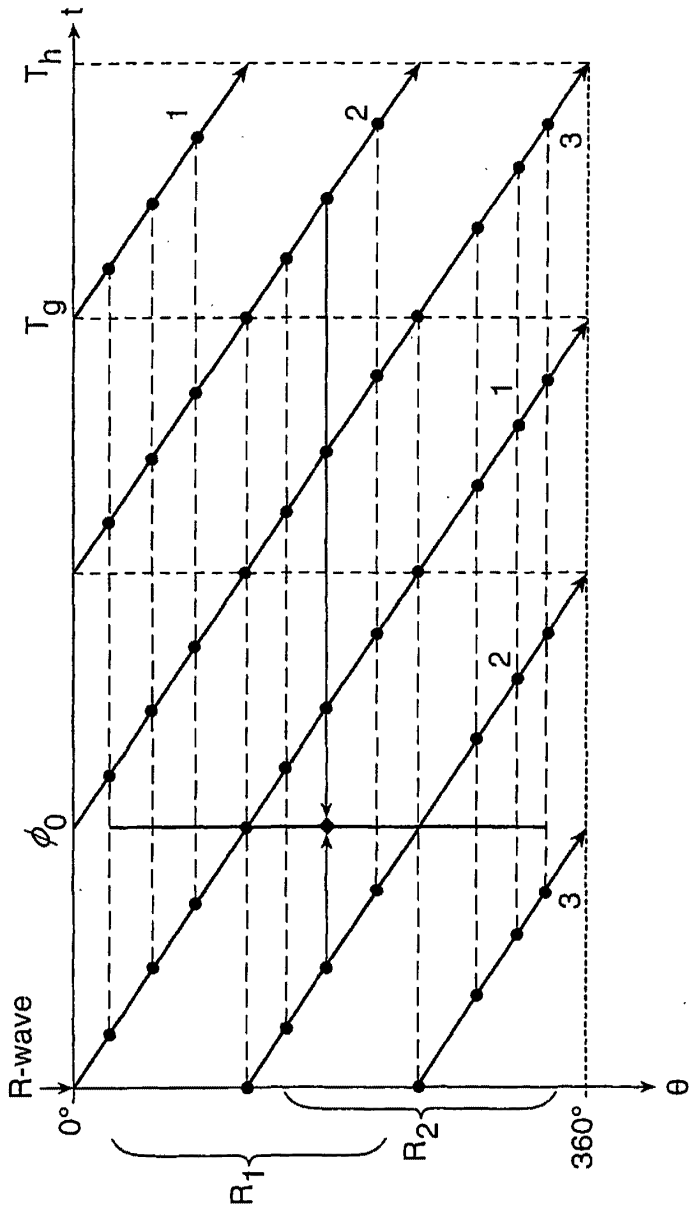


FIG. 34

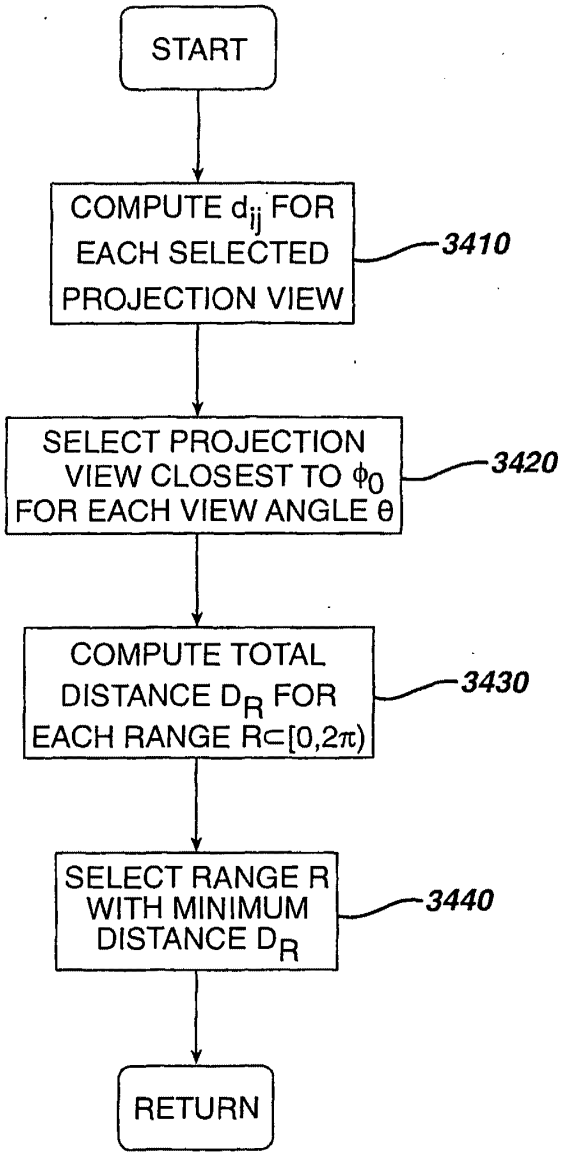
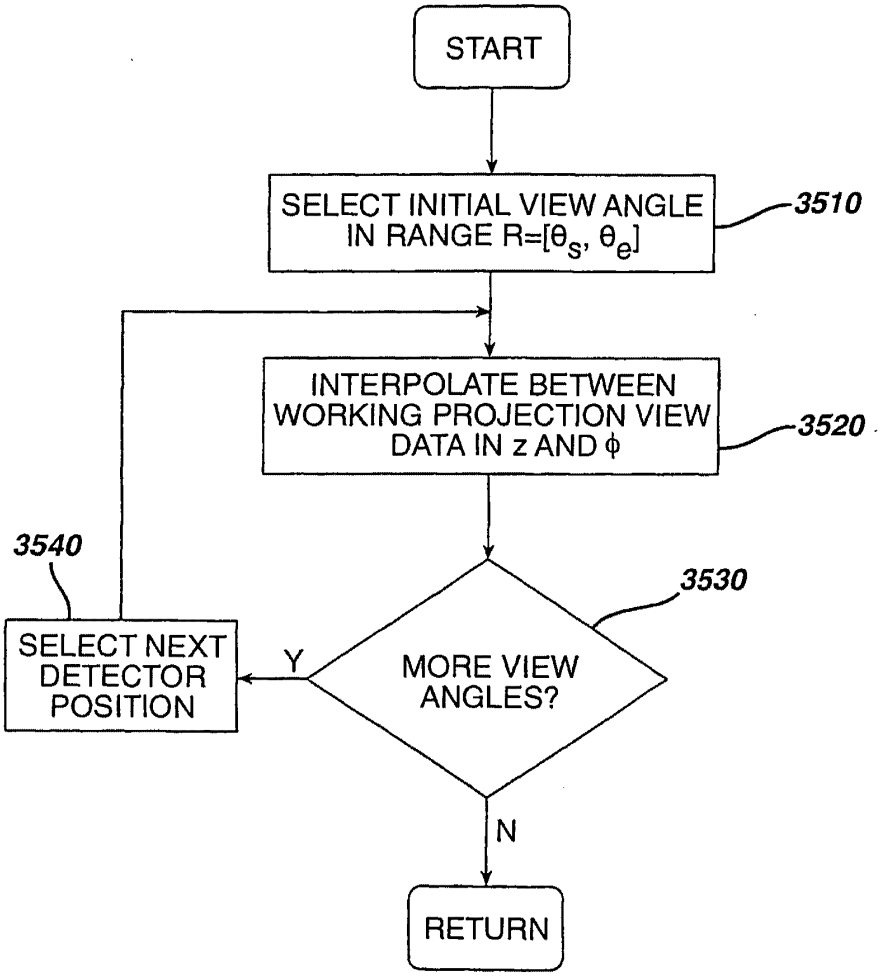

START
COMPUTE d_{ij} FOR EACH SELECTED PROJECTION VIEW
3410
SELECT PROJECTION VIEW CLOSEST TO ϕ_0 FOR EACH VIEW ANGLE θ
3420
COMPUTE TOTAL DISTANCE D_R FOR EACH RANGE $R \subset [0,2\pi)$
3430
SELECT RANGE R WITH MINIMUM DISTANCE D_R
3440
RETURN

FIG. 35


START
SELECT INITIAL VIEW ANGLE IN RANGE R=[θs, θe]
3510
INTERPOLATE BETWEEN WORKING PROJECTION VIEW DATA IN z AND ϕ
3520
3530
MORE VIEW ANGLES?
Y
N
3540
SELECT NEXT DETECTOR POSITION
RETURN

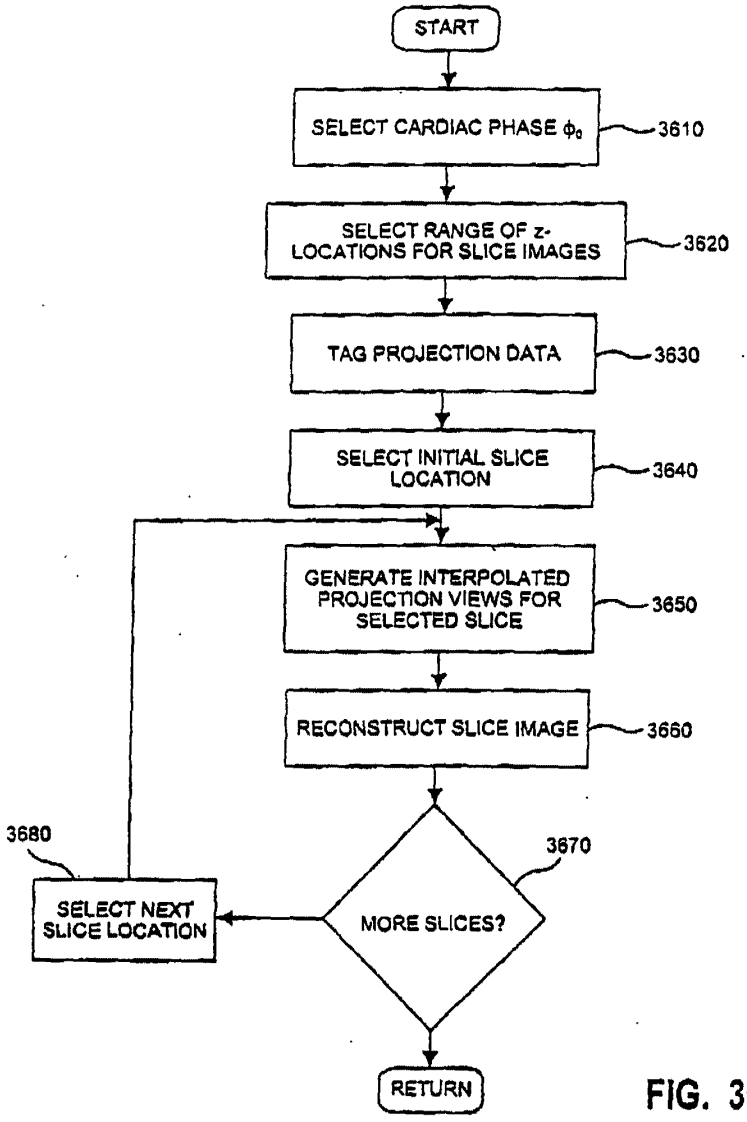


FIG. 36

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FIG. 37

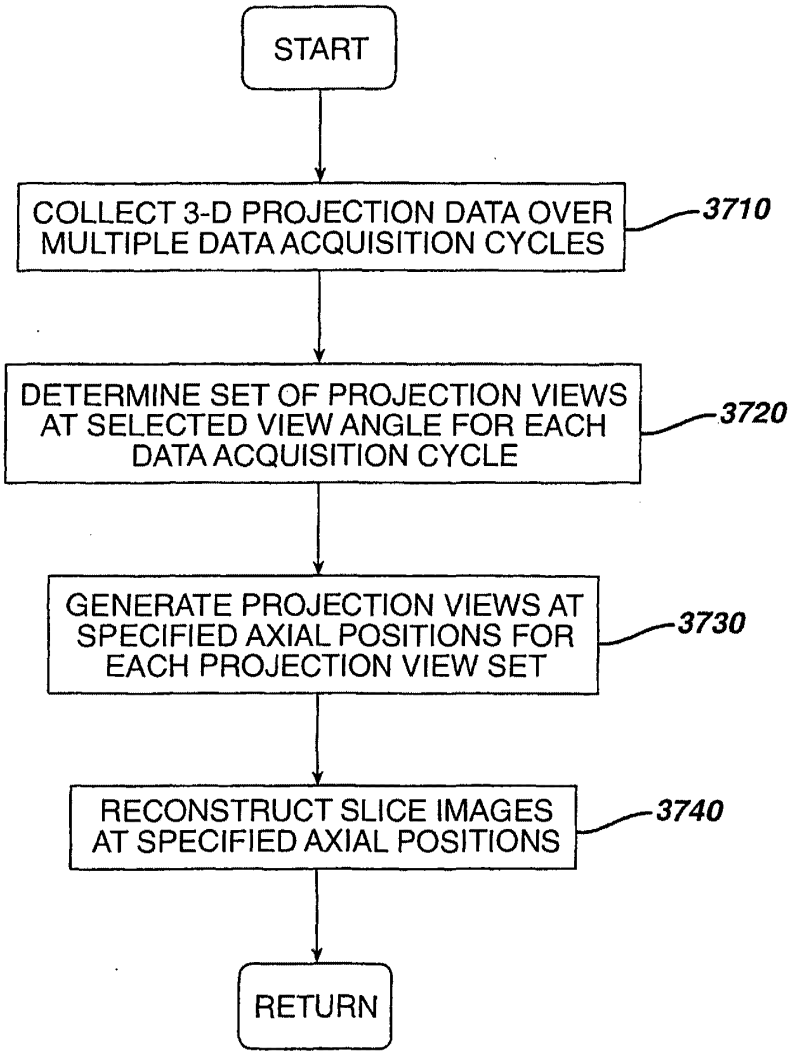

START
COLLECT 3-D PROJECTION DATA OVER MULTIPLE DATA ACQUISITION CYCLES
3710
DETERMINE SET OF PROJECTION VIEWS AT SELECTED VIEW ANGLE FOR EACH DATA ACQUISITION CYCLE
3720
GENERATE PROJECTION VIEWS AT SPECIFIED AXIAL POSITIONS FOR EACH PROJECTION VIEW SET
3730
RECONSTRUCT SLICE IMAGES AT SPECIFIED AXIAL POSITIONS
3740
RETURN

FIG. 38

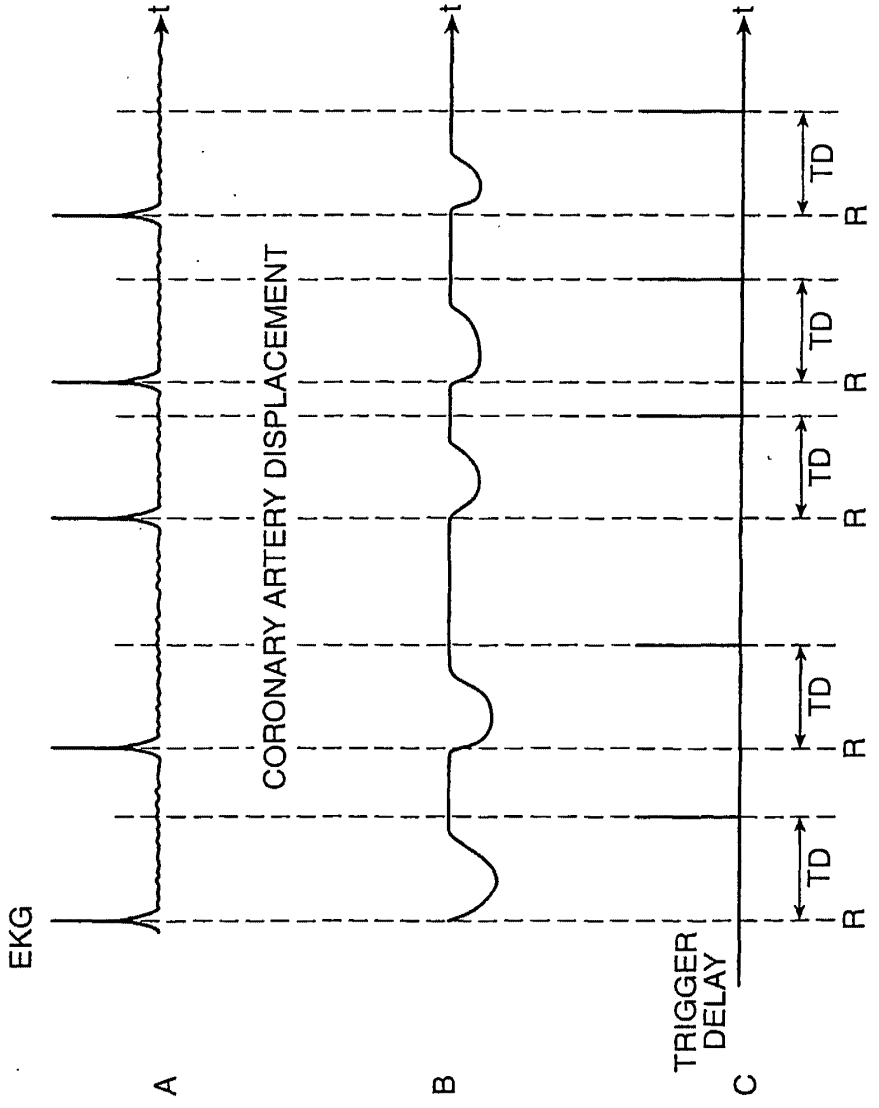
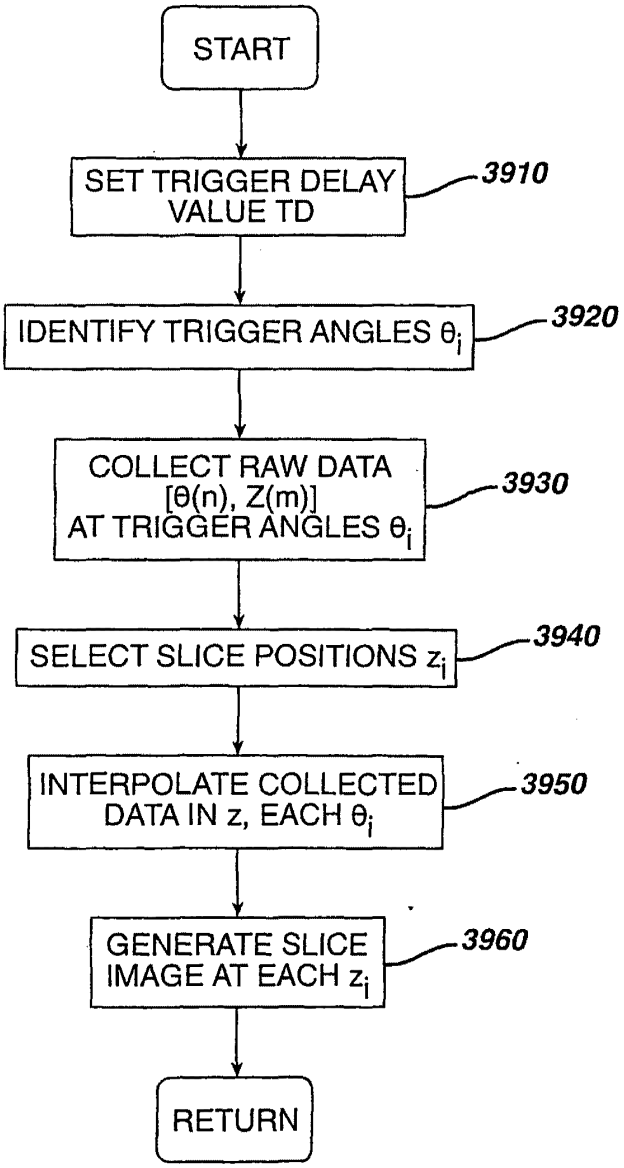

EKG
CORONARY ARTERY DISPLACEMENT
TRIGGER DELAY
A
B
C
t
t
t
TD
TD
TD
TD
TD
R
R
R
R
R

FIG. 39


START
SET TRIGGER DELAY VALUE TD
3910
IDENTIFY TRIGGER ANGLES θi
3920
COLLECT RAW DATA [θ(n), Z(m)] AT TRIGGER ANGLES θi
3930
SELECT SLICE POSITIONS zi
3940
INTERPOLATE COLLECTED DATA IN z, EACH θi
3950
GENERATE SLICE IMAGE AT EACH zi
3960
RETURN

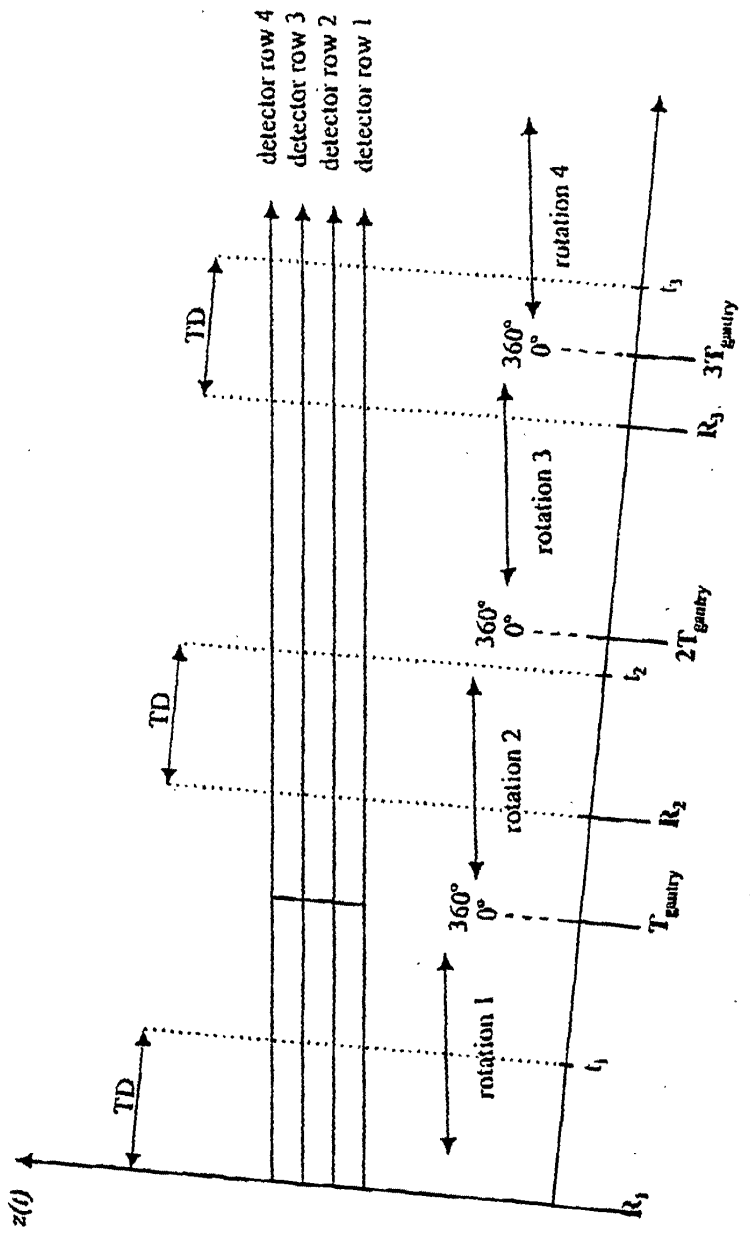
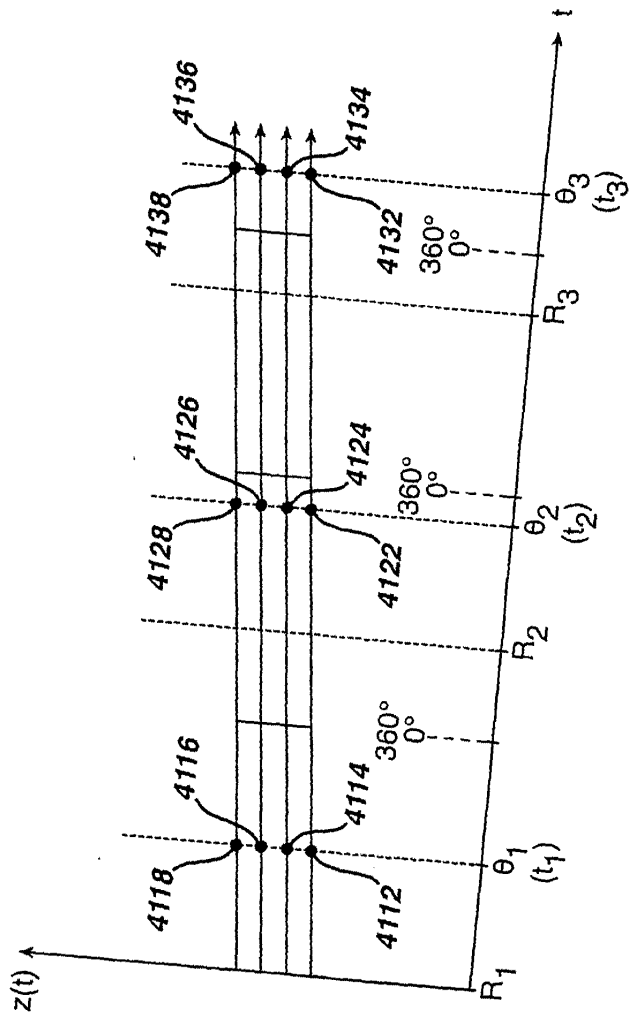

detector row 4
detector row 3
detector row 2
detector row 1
TD
TD
TD
rotation 4
rotation 3
rotation 2
rotation 1
360°
0°
360°
0°
360°
0°
t_3
t_2
t_1
$3T_{gantry}$
$2T_{gantry}$
T_{gantry}
R_3
R_2
R_1
z(t)

FIG. 40

FIG. 41


t
z(t)
4136
4134
4138
4132
360°
0°
θ3
(t3)
R3
4126
4124
4128
4122
360°
0°
θ2
(t2)
R2
4116
4114
4118
4112
360°
0°
θ1
(t1)
R1

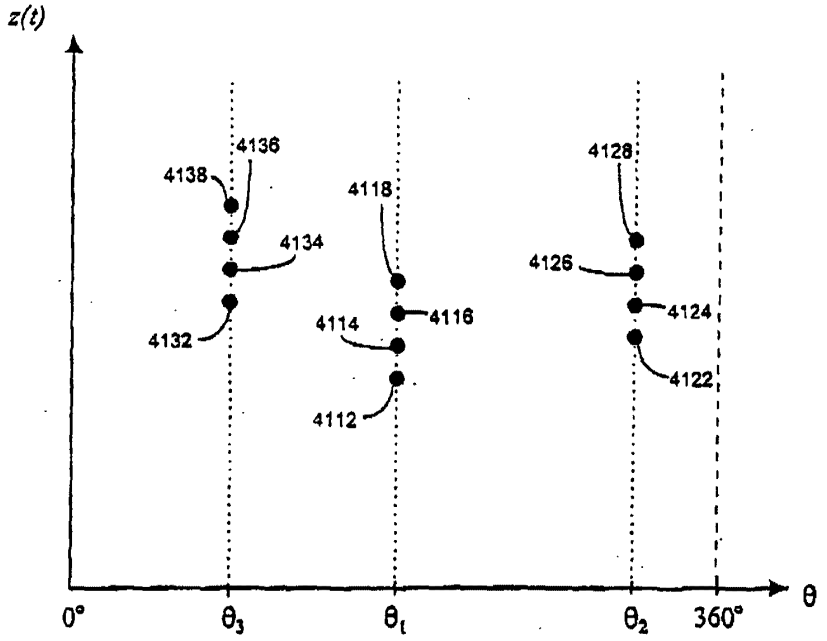

z(t)
4136
4138
4134
4132
4118
4116
4114
4112
4128
4126
4124
4122
θ
0°
θ3
θt
θ2
360°

FIG. 42

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 01/00904

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06T11/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06T

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, INSPEC, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 627 868 A (TOKI YUSUKE ET AL) 6 May 1997 (1997-05-06) abstract; figures 3,4,6-12 column 2, line 19 - last line column 6, line 47 -column 7, line 22 column 8, line 8 - line 31 column 14, line 26 - line 34	1-9
A	---	10-71
A	US 5 889 833 A (SILVER MICHAEL D) 30 March 1999 (1999-03-30) abstract column 5, line 7 -column 6, line 20	1-71
A	---	
	EP 0 430 549 A (GEN ELECTRIC) 5 June 1991 (1991-06-05) abstract	1-71

	-/--	

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

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 July 2001	18/07/2001

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, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Diallo, B

Form PCT/ISA/210 (second sheet) (July 1992)

Volkswagen Exhibit 1002, Page 608 of 885

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 01/00904

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 838 756 A (TAGUCHI KATSUYUKI ET AL) 17 November 1998 (1998-11-17)	
A	US 5 243 284 A (NOLL DOUGLAS C) 7 September 1993 (1993-09-07)	

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

Volkswagen Exhibit 1002, Page 609 of 885

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 01/00904

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5627868 A	06-05-1997	JP 3090400 B	18-09-2000
		JP 7323027 A	12-12-1995
		DE 69425631 D	28-09-2000
		DE 69425631 T	19-04-2001
		EP 0655713 A	31-05-1995
		EP 0953942 A	03-11-1999
		JP 7194592 A	01-08-1995
		JP 2000189414 A	11-07-2000
		US 5513237 A	30-04-1996
		US 5566218 A	15-10-1996
		US 5608772 A	04-03-1997
		JP 2000342573 A	12-12-2000
		JP 2000350724 A	19-12-2000
		US 5594772 A	14-01-1997
		US 5612985 A	18-03-1997
US 5889833 A	30-03-1999	JP 11004823 A	12-01-1999
EP 0430549 A	05-06-1991	US 5216601 A	01-06-1993
		CA 2021623 A	23-05-1991
		IL 96320 A	08-12-1995
		JP 1945090 C	23-06-1995
		JP 3186250 A	14-08-1991
		JP 6069452 B	07-09-1994
US 5838756 A	17-11-1998	JP 9187449 A	22-07-1997
		JP 9187450 A	22-07-1997
US 5243284 A	07-09-1993	NONE	

Form PCT/ISA/210 (patent family annex) (July 1992)

Docket No.: 27592-00987-US
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Stephane Bonnet et al.

Application No.: 10/955,037 | Confirmation No.: 4535

Filed: September 30, 2004 | Art Unit: 2624

For: Method of reconstructing an image with data acquisition according to several imagery modes and synchronisation of image series | Examiner: J. W. Lee

RESPONSE UNDER 37 C.F.R. 1.112 (NON-FINAL OFFICE ACTION)

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

INTRODUCTORY COMMENTS

This is in response to the non-final Office Action mailed July 12, 2010, in the above-captioned case.

Amendments to the Claims are reflected in the Listing of Claims which begins on page 2 of this paper.

Remarks begin on page 6 of this paper.

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
10/955,037	09/30/2004	

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY ☐ RATE ($)	SMALL ENTITY ☐ FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	11/10/2010	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X $ =		OR	X $52=	0
	Independent (37 CFR 1.16(h))	* 4	Minus	***3	= 1	X $ =		OR	X $220=	220
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE	0	OR	TOTAL ADD'L FEE	220

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =		OR	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =		OR	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/EAON SMALLWOOD/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Patent Application Fee Transmittal

Application Number:	10955037
Filing Date:	30-Sep-2004
Title of Invention:	Method of reconstructing an image with data acquisition according to several imagery modes and synchronisation of image series
First Named Inventor/Applicant Name:	Stephane Bonnet
Filer:	Burton A. Amernick/Mary Ann Taylor
Attorney Docket Number:	27592-00987- US

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Independent claims in excess of 3	1201	1	220	220
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 1 month with $0 paid	1251	1	130	130
Miscellaneous:				
		Total in USD ($)		**350**

Electronic Acknowledgement Receipt	
EFS ID:	8804921
Application Number:	10955037
International Application Number:	
Confirmation Number:	4535
Title of Invention:	Method of reconstructing an image with data acquisition according to several imagery modes and synchronisation of image series
First Named Inventor/Applicant Name:	Stephane Bonnet
Customer Number:	30678
Filer:	Burton A. Amernick/Mary Ann Taylor
Filer Authorized By:	Burton A. Amernick
Attorney Docket Number:	27592-00987- US
Receipt Date:	10-NOV-2010
Filing Date:	30-SEP-2004
Time Stamp:	07:43:55
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$350
RAM confirmation Number	7258
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1		Response_11_10_10.pdf	147748 c82fd3fa7f5e558e25179bfc8f985fc9276c3e2a	yes	13

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Amendment/Req. Reconsideration-After Non-Final Reject	1	1
Claims	2	6
Applicant Arguments/Remarks Made in an Amendment	7	13

Warnings:

Information:

2	Fee Worksheet (PTO-875)	fee-info.pdf	31735 462e504b37362a173a1061c09ee692a8b0e96973	no	2

Warnings:

Information:

Total Files Size (in bytes):	179483

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

AMENDMENTS TO THE CLAIMS

This Listing of Claims will replace all prior versions and listings of claims in this application.

Listing of Claims:

1.-14. (Cancelled)

15. (Currently Amended) A method of forming an image of a mobile object, comprising:

obtaining a plurality of first images of the mobile object using a first imaging technique and an associated plurality of first movement measurements of the mobile object at movement states corresponding to movement states of said plurality of first images;

obtaining a plurality of second images of the mobile object using a second imaging technique and an associated plurality of second movement measurements of the mobile object at movement states corresponding to movement states of said plurality of second images, wherein the plurality of second movement measurements are distinct from the plurality of first movement measurements; and

forming an image of the mobile object based on said plurality of first images and said associated plurality of first movement measurements and on said plurality of said second images and said associated plurality of second movement measurements,

wherein the first imaging technique is different from the second imaging technique.

16. (Currently Amended) The method of Claim 15, further comprising:

time-synchronizing said first movement measurements and said second movement measurements.

17. (Previously Presented) The method of Claim 15, further comprising:

forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images.

18. (Previously Presented) The method of Claim 17, further comprising:

spatially-synchronizing said first reconstructed images and said second reconstructed images.

19. (Previously Presented) The method of Claim 15, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique.

20. (Currently Amended) The method of Claim 15, further comprising:

spatially-synchronizing information based on said plurality of first movement measurements and information based on said plurality of second movement measurements.

21. (Currently Amended) The method of Claim 15, further comprising:

forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first movement measurements, said plurality of second images, and said plurality of second movement measurements.

22. (Previously Presented) The method of Claim 21, wherein said forming an image of the mobile object comprises combining said displacement fields.

23. (Currently Amended) The method of Claim 21, wherein said forming displacement fields comprises:

estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first movement measurements, and said plurality of second movement measurements, in order to form said displacement fields.

24. (Previously Presented) The method of Claim 23, wherein at least one of said movement estimates is formed relative to a reference time.

25. (Currently Amended) The method of Claim 15, wherein said plurality of first movement measurements and said plurality of second movement measurements are taken using separate measurement systems respectively associated with separate imaging systems used to obtain said plurality of first images and said plurality of second images.

26. (Currently Amended) An apparatus to form an image of a mobile object, comprising:

means for obtaining a plurality of first images of the mobile object using a first imaging technique; means for obtaining an associated plurality of first movement measurements of the mobile object at movement states corresponding to movement states of said plurality of first images;

means for obtaining a plurality of second images of the mobile object using a second imaging technique; means for obtaining an associated plurality of second movement measurements of the mobile object at movement states corresponding to movement states of said plurality of second images, wherein the plurality of second movement measurements are distinct from the plurality of first movement measurements; and

means for forming an image of the mobile object based on said plurality of first images and said associated plurality of first movement measurements and on said plurality of said second images and said associated plurality of second movement measurements,

wherein the first imaging technique is different from the second imaging technique.

27. (Previously Presented) The apparatus of Claim 26, further comprising:

means for forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images.

28. (Previously Presented) The apparatus of Claim 26, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique.

29. (Currently Amended) The apparatus of Claim 26, further comprising:

means for forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first movement measurements, said plurality of second images, and said plurality of second movement measurements.

30. (Previously Presented) The apparatus of Claim 29, wherein said means for forming an image of the mobile object comprises means for combining said displacement fields.

31. (Currently Amended) The apparatus of Claim 29, wherein said means for forming displacement fields comprises:

means for estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first movement measurements, and said plurality of second movement measurements, in order to form said displacement fields.

32. (Previously Presented) The apparatus of Claim 31, wherein at least one of said movement estimates is to be formed relative to a reference time.

33. (New) A method of forming an image of a mobile object, comprising:

obtaining a plurality of first images of the mobile object using a first imaging technique and an associated plurality of first measurements of the mobile object at movement states corresponding to movement states of said plurality of first images;

obtaining a plurality of second images of the mobile object using a second imaging technique and an associated plurality of second measurements of the mobile object at movement states corresponding to movement states of said plurality of second images, wherein the plurality of second measurements are distinct from the plurality of first measurements, wherein said plurality of first measurements and said plurality of second measurements are taken using one or more systems separate from one or more systems used to obtain said plurality of first images and said plurality of second images; and

forming an image of the mobile object based on said plurality of first images and said associated plurality of first measurements and on said plurality of said second images and said

associated plurality of second measurements, wherein the first imaging technique is different from the second imaging technique.

34. (New) An apparatus to form an image of a mobile object, comprising:

means for obtaining a plurality of first images of the mobile object using a first imaging technique;

means for obtaining an associated plurality of first measurements of the mobile object at movement states corresponding to movement states of said plurality of first images;

means for obtaining a plurality of second images of the mobile object using a second imaging technique;

means for obtaining an associated plurality of second measurements of the mobile object at movement states corresponding to movement states of said plurality of second images, wherein the plurality of second measurements are distinct from the plurality of first measurements,

wherein said means for obtaining said plurality of first measurements and said means for obtaining said plurality of second measurements are separate from said means for obtaining said plurality of first images and said means for obtaining said plurality of second images; and

means for forming an image of the mobile object based on said plurality of first images and said associated plurality of first measurements and on said plurality of said second images and said associated plurality of second measurements, wherein the first imaging technique is different from the second imaging technique.

REMARKS

Applicant thanks the Examiner for the careful consideration given to this application. Reconsideration is now respectfully requested in view of the amendment above and the following remarks.

Claims 15-34 are pending in this application. Claims 15, 26, 33, and 34 are independent claims. Claims 15, 16, 20, 21, 23, 25, 26, 29, and 31 have been amended herein without prejudice. Claims 1-14 were previously cancelled without prejudice or disclaimer. New Claims 33 and 34 have been added, and it is respectfully submitted that these claims find support at least at paragraphs [0013] and [0014] of the application as published (i.e., U.S. Patent Application Publication No. 2005/0285857; in the remainder of this paper, all references to the specification use the paragraph numbering of this published application). Accordingly, no new matter has been added. Reconsideration and allowance of the present application are respectfully requested.

Interview Summary

Applicants' representative thanks the Examiner for granting an interview on October 12, 2010. The interview was attended by David Morse, Examiner John Lee, and Jefferson Cheatham, David Morse's assistant. The discussion focused on the anticipation rejections, proposed amendments, and the new claims. No agreement was reached during the interview. However, the Examiner agreed to take into consideration the amendments and new claims.

Claim Rejections under 35 U.S.C. §102

Claims 15-20 and 25-28 stand rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent Publication No. 2003/0004405 to Townsend et al. (hereinafter "Townsend et al."). Applicants request reconsideration and withdrawal of these rejections for at least the following reasons.

Under 35 U.S.C. §102 "[a] claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Accordingly, to anticipate any of Claims 15-20 and 25-28, Townsend must teach

each and every element recited thereby. Townsend fails to teach all of the recited elements of any of these claims -- and hence fails to anticipate any of these claims as a matter of law.

Amended Claim 15 recites,

> A method of forming an image of a mobile object, comprising:
> obtaining a plurality of first images of the mobile object using a first imaging technique and an associated plurality of first ***movement*** measurements of the mobile object at movement states corresponding to movement states of said plurality of first images;
> obtaining a plurality of second images of the mobile object using a second imaging technique and an associated plurality of second ***movement*** measurements of the mobile object at movement states corresponding to movement states of said plurality of second images, wherein the plurality of second ***movement*** measurements are distinct from the plurality of first ***movement*** measurements; and
> forming an image of the mobile object based on said plurality of first images and said associated plurality of first ***movement*** measurements and on said plurality of said second images and said associated plurality of second ***movement*** measurements,
> wherein the first imaging technique is different from the second imaging technique. ***(Emphasis added)***

Support for such a limitation may be found throughout the application as originally filed, such as at paragraphs [0013] - [0014]. Townsend fails to teach, or for that matter even suggest, such a method. To the contrary, Townsend instead teaches the use of CT and PET imaging and, at paragraph [0080] discusses "image 'fusion'" to combine their results. Applicants note that paragraph [0080] of Townsend et al. specifically states:

> The PET images are therefore fully quantitative and are interpolated and displayed with the same pixel size as the CT images. PET images are displayed either adjacent to, or superimposed on, CT images for simultaneous interpretation of functional and morphological information. In one embodiment, the PET and CT images are displayed side by side in a viewing tool with linked cross-hair cursors, so that positional correspondence between the two image sets is easily established. A second technique of image `fusion` is also employed, where the two different image sets are combined into a single image. See FIG. 3. For display of the fused PET and CT images, an alternating pixel method is extended to a 3D display format. Since the PET images

> have an isotropic resolution of approximately 10 mm for whole-body oncology imaging, the images are interpolated into the CT image space without loss of information in the PET image, thus preserving the resolution of the CT image. Because image fusion methods can obscure low-contrast objects, the CT display panel can be toggled between CT only and fused PET/CT mode. The viewing panels also have independent color scales and can be switched between transverse, sagittal, and coronal viewing modes.

As stated above, Townsend explains, "For display of the fused PET and CT images, an alternating pixel method is extended to a 3D display format," and "the [PET] images are interpolated into the CT image space." That is, Townsend teaches creating a combined image based on two different imaging techniques, but does not teach "obtaining … images of the mobile object using a first imaging technique and an associated plurality of first ***movement*** measurements of the mobile object," as recited in Claim 15. Similarly, Townsend, does not teach "obtaining … images of the mobile object using a second imaging technique and an associated plurality of second ***movement*** measurements of the mobile object," also recited in Claim 15. In fact, for example, in the abstract and paragraph [0035], Townsend provides a system in which such measurements are not necessary because, due to the physically-known relationship between the CT and PET scans, the resulting images may be combined without registration (i.e., they are inherently co-registered); see also, paragraph [0036]).

Applicants further note in paragraph [0109], Townsend specifically addresses the difficulty of obtaining images of a mobile object, stating "regions such as the thorax, respiration, and cardiac motion may result in some intrinsic misalignment," as well as "on the CT scan, lung boundaries and regions of either high or low attenuation are susceptible to motion artifacts." Even though Townsend discusses the difficulties of obtaining images of a mobile object, Townsend's solutions do not teach or even suggest, for that matter, the recited " … an associated plurality of … ***movement*** measurements of the mobile object." Rather, Townsend discusses the use of a spiral CT scan to address the problems of obtaining images of a mobile object using a CT scanner. In particular, Townsend states in paragraph [0109], "the shorter scan times possible with spiral CT have essentially eliminated artifacts from cardiovascular motion." Therefore, Townsend proposes to deal with the complexities associated with imaging a mobile object by taking advantage of a short scan time associated with a spiral CT, and not "using an associated

plurality of … ***movement*** measurements of the mobile object," as is recited in Claim 15. Townsend proposes another solution for dealing with the difficulties of imaging a mobile object, which is directed to PET imaging. In particular, Townsend discusses the use of an "ungated PET image, which represents an average over the scan duration of typically 5-10 minutes. During the scan, the patient breathes normally and the resulting PET image is an integration over the respiratory and cardiac cycles. *Townsend, pg. 12, par. [0109].* Using this ungated PET image is not and does not equate to the recited "using an associated plurality of … ***movement*** measurements of the mobile object."

Thus, Townsend indeed discusses the difficulties of imaging a mobile object. However, Townsend does not teach, or even suggest, for that matter, using an associated plurality of … ***movement*** measurements of the mobile object," as is recited by Claim 15. Accordingly, Applicants respectfully request this rejection of Claim 15 under 35 U.S.C. §102 be withdrawn, at least by virtue that Townsend fails to teach or suggest each of the limitations of Claim 15. Applicants also request reconsideration and removal of these rejections of Claims 16-20 and 25 as well, at least by virtue of these claims' ultimate dependency upon base Claim 15.

Turning now to Claim 26, while of differing scope it has been amended to analogously recite,

> An apparatus to form an image of a mobile object, comprising:
> means for obtaining a plurality of first images of the mobile object using a first imaging technique and an associated plurality of first ***movement*** measurements of the mobile object at movement states corresponding to movement states of said plurality of first images;
> means for obtaining a plurality of second images of the mobile object using a second imaging technique and an associated plurality of second ***movement*** measurements of the mobile object at movement states corresponding to movement states of said plurality of second images, wherein the plurality of second ***movement*** measurements are distinct from the plurality of first ***movement*** measurements; and
> means for forming an image of the mobile object based on said plurality of first images and said associated plurality of first ***movement*** measurements and on said plurality of said second images and said associated plurality of second ***movement*** measurements,

wherein the first imaging technique is different from the second imaging technique. ***(Emphasis added)***

Accordingly, Applicants also request reconsideration and removal of the rejections of Claim 26 under 35 U.S.C. §102 for at least the foregoing reasons as well. Applicants also request reconsideration and removal of these rejections of Claims 26-28 as well, at least by virtue of these claims' ultimate dependency upon base Claim 26.

Therefore, Applicants respectfully request that this rejection of claims 15-20 and 25-28 under 35 U.S.C. §102 be withdrawn.

Claim Rejections Under 35 U.S.C. §103

Claims 21-23 and 29-31 stand rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent Publication No. 2003/0004405 to Townsend et al. (hereinafter "Townsend et al.") in view of U.S. Patent Publication No. 2004/0141638 to Acar et al. (hereinafter "Acar et al."). Claims 24 and 32 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Townsend et al. in view of Acar et al., and in further view of "Scale-Space and Edge Detection Using Anisotrophic Diffusion" to Perona et al. (hereinafter "Perona et al."). Applicants respectfully request reconsideration and withdrawal of these rejections for at least the following reasons.

Each of claims 21-24 and 29-32 ultimately depend either from Claim 15 or Claim 26. As discussed above, Townsend fails to teach or suggest each of the recited limitations of Claim 15 or Claim 26. Accordingly, Applicants respectfully request these rejections of Claims 21-24 and 29-32 under 35 U.S.C. §103 be withdrawn, at least by virtue of these claims' ultimate dependency from base Claim 15 or 26.

New Claims

New Claims 33 and 34 have been added. Claim 33 recites, at least, that "said plurality of first measurements and said plurality of second measurements are taken using one or more systems separate from one or more systems used to obtain said plurality of first images and said plurality of second images," and Claim 34 recites, at least, that "said means for obtaining said plurality of first measurements and said means for obtaining said plurality of second

measurements are distinct from said means for obtaining said plurality of first images and said means for obtaining said plurality of second images." As stated above, support for the new Claims 33 and 34 may be found at least at paragraphs [0013] and [0014]. As discussed above, Townsend does not disclose the recited "obtaining … images of the mobile object using a first imaging technique and an associated plurality of first … measurements of the mobile object," or "obtaining … images of the mobile object using a second imaging technique and an associated plurality of second … measurements of the mobile object." Since Townsend doesn't teach or suggest the limitations of Claims 15 for at least the above reasons, it also fails to teach or suggest the recited limitations of New Claims 33 and 34 of "said plurality of first measurements and said plurality of second measurements are taken using one or more systems separate from one or more systems used to obtain said plurality of first images and said plurality of second images," and "said means for obtaining said plurality of first measurements and said means for obtaining said plurality of second measurements are separate from said means for obtaining said plurality of first images and said means for obtaining said plurality of second images," respectively.

Disclaimer

Applicants may not have presented all possible arguments or have refuted the characterizations of either the claims or the prior art as found in the Office Action. However, the lack of such arguments or refutations is not intended to act as a waiver of such arguments or as concurrence with such characterizations.

CONCLUSION

In view of the above, consideration and allowance are respectfully solicited.

In the event the Examiner believes an interview might serve in any way to advance the prosecution of this application, the undersigned is available at the telephone number noted below.

The Office is authorized to charge any necessary fees to Deposit Account No. 22-0185.

Applicants believe no fee is due with this response. However, if a fee is due, please charge our Deposit Account No. 22-0185, under Order No. 27592-00987-US from which the undersigned is authorized to draw.

Respectfully submitted,

CONNOLLY BOVE LODGE & HUTZ LLP

DATE: November 10, 2010 By: _____

David M. Morse
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Notice of References Cited	Application/Control No. 10/955,037	Applicant(s)/Patent Under Reexamination BONNET ET AL.	
	Examiner JOHN Wahnkyo LEE	Art Unit 2624	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-6,246,784 B1	06-2001	Summers et al.	382/128
*	B	US-2003/0004405 A1	01-2003	Townsend et al.	600/407
*	C	US-2003/0212320 A1	11-2003	Wilk et al.	600/407
*	D	US-2004/0141638 A1	07-2004	Acar et al.	382/131
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
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	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	10955037	BONNET ET AL.
	Examiner	Art Unit
	Lee, John W	2112

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/27/2006	09/07/2007	05/25/2008	11/07/2008	04/22/2009	11/20/2009	07/09/2010	01/12/2011	
	1	✓	-	-	-	-	-	-	-	
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	3	✓	-	-	-	-	-	-	-	
	4	✓	-	-	-	-	-	-	-	
	5	✓	-	-	-	-	-	-	-	
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	30			✓	✓	✓	✓	✓	✓	
	31			✓	✓	✓	✓	✓	✓	
	32			✓	✓	✓	✓	✓	✓	
	33								✓	
	34								✓	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	10955037	BONNET ET AL.
	Examiner	Art Unit
	Lee, John W	2112

SEARCHED			
Class	Subclass	Date	Examiner
382	128	12/26/2006	John W. Lee
345	420	12/26/2006	John W. Lee
382	128	11/06/2008	John W. Lee

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor Search	12/26/2006	John W. Lee
East Search	12/26/2006	John W. Lee
IEEE (Non- Patent Literature Search)	12/26/2006	John W. Lee
EAST Search	11/06/2008	John W. Lee
EAST Search	4/22/2009	John W. Lee
EAST Search	11/20/2009	John W. Lee
Inventor Search (using EDAN)	7/9/2010	John W. Lee
Inventor Search (using EAST)	7/9/2010	John W. Lee
Assignee Search (using EAST)	7/9/2010	John W. Lee
EAST Search	7/1/2010	John W. Lee
Plus Search	7/6/2010	John W. Lee
NPL search (using google)	7/5/2010	John W. Lee
382/128, 345/420 and 600/427 (combined with keyword search)	7/1/2010	John W. Lee
EAST Search	1/12/2011	John W. Lee

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner

/JOHN W LEE/ Examiner.Art Unit 2624	

Receipt date: 10/05/2010

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10955037 - GAU: 2624

PTO/SB/08a (07-09)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 2

	Complete if Known
Application Number	10/955,037-Conf. #4535
Filing Date	September 30, 2004
First Named Inventor	Stephane Bonnet
Art Unit	2624
Examiner Name	J. W. Lee
Attorney Docket Number	27592-00987-US

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	AA*	US-20030004405	01-02-2003	Townsend et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
	BA	WO-200180184-A1	10-25-2001	Gen Electric		
	BB	EP-1087337-A1	03-28-2001	Ge Medical Syst Sa		

Examiner Signature	/John Lee/	Date Considered	01/12/2011

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Sheet 2 of 2

Complete if Known	
Application Number	10/955,037-Conf. #4535
Filing Date	September 30, 2004
First Named Inventor	Stephane Bonnet
Art Unit	2624
Examiner Name	J. W. Lee
Attorney Docket Number	27592-00987-US

NON PATENT LITERATURE DOCUMENTS

Examiner Initials	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	CA	Timo Makela et al., "A Review of Cardiac Image Registration Methods," IEEE Transactions on Medical Imaging, IEEE Service Center, Piscataway, NJ, vol. 21, no. 9, 1 Sept. 2002	
	CB	Calvert et al., "Crossmodal identification," Trends in Cognitive Sciences, Elsevier Science, Oxford, GB, vol. 2, no. 7, 1 July 1998, pages 247-253	
	CC	J. Ashburner et al., "Multimodal image coregistration and partitioning - a unified framework," Neuroimage, vol. 6, no. 3, October 1997, pages 209-217	

Examiner Signature	/John Lee/	Date Considered	01/12/2011

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/955,037	09/30/2004	Stephane Bonnet	27592-00987- US	4535

30678 7590 01/13/2011
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WASHINGTON, DC 20006

EXAMINER	
LEE, JOHN W	
ART UNIT	PAPER NUMBER
2624	

MAIL DATE	DELIVERY MODE
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The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/955,037	BONNET ET AL.	
	Examiner	Art Unit	
	JOHN Wahnkyo LEE	2624	

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- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *10 November 2010*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-34* is/are pending in the application.

4a) Of the above claim(s) *1-14* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *15-34* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *20101005*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

- Claims 15-34 are pending; claims 33-34 are added; claims 15-16, 20-21, 23, 25-26, 29 and 31 are amended; claims 1-15 are canceled.

Response to Amendments/Arguments

2. Applicant's amendment filed 10 November 2010 is entered and has been fully considered.

15-20 and 25-28

3. Applicant's arguments of the rejected claims 15-20 and 25-28 under 35 U.S.C. § 102 (b) have been considered but are moot in view of the new ground(s) of rejection.

4. Applicant's arguments of the rejected claims 21024 and 29-32 under 35 U.S.C. § 103(a) have been considered but are moot in view of the new ground(s) of rejection.

Information Disclosure Statement

5. The information disclosure statement filed 5 October 2010 complies with the provisions of 37 CFR 1.97, 1.98. It has been placed in the application file, and the information referred to therein has been considered as to the merits[1]. An initialed and dated copy of Applicant's IDS form 1449, Paper No. 20101005, is attached to the instant Office action.

[1] See MPEP § 609

Claim Rejections - 35 USC § 102

6. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

7. Claims 15-20, 25-28 and 33-34 are rejected under 35 U.S.C. 102(b) as being anticipated by Townsend et al. (US 2003/0004405 A1).

a. Regarding claim 15, Townsend discloses a method of forming an image (Fig.3; "image fusion" at ¶ 0080) of a mobile object (Fig. 2b; "patient" at ¶¶ 0070 and 0073), comprising:

obtaining a plurality of first images ("CT images" at ¶ 0075) of the mobile object (Fig. 2b; "patient" at ¶¶ 0070 and 0073) using a first imaging technique ("X-ray CT" at ¶¶ 0070 and 0073) and an associated plurality of first movement (Fig. 11A; "internal organ movement" at abstract and ¶ 0101) measurements (Fig. 2b-12; "X-ray CT detectors" at ¶ 0073) of the mobile object (Fig. 2b; "patient" at ¶¶ 0070 and 0073) at movement states (Fig. 2b-18; "patient bad [being] movable") corresponding to movement states ("a patient may be … moved into position for … X-ray CT scan" at ¶ 0071) of said plurality of first images ("CT images" at ¶ 0075);

obtaining a plurality of second images ("PET images" at ¶0075) of the mobile object (Fig. 2b; "patient" at ¶¶ 0070 and 0073) using a second imaging technique ("PET" at ¶¶ 0070 and 0073) and an associated plurality of second movement (Fig. 11B; "internal organ movement" at abstract and ¶ 0101) measurements (Fig. 2b-14; "PET

tomograph detectors" at ¶ 0073) of the mobile object (Fig. 2b; "patient" at ¶¶ 0070 and 0073) at movement states (Fig. 2b-18; "patient bad [being] movable") corresponding to movement states ("a patient may be … moved into position for … PET scan" at ¶ 0071) of said plurality of second images ("PET images" at ¶0075), wherein the plurality of second measurements (Fig. 2b-14; "PET tomograph detectors" at ¶ 0073) are distinct from the plurality of first measurements(Fig. 2b-12; "X-ray CT detectors" at ¶ 0073; "The second measurements are PET tomograph detectors that are different and distinct with the first measurements, which are X-ray CT detectors"); and

forming an image (Fig.3; "image fusion" at ¶ 0080) of the mobile object (Fig. 2b; "patient" at ¶¶ 0070 and 0073) based on said plurality of first images ("CT images" at ¶ 0075) and said associated plurality of first movement (Fig. 11A; "internal organ movement" at abstract and ¶ 0101) measurements (Fig. 2b-12; "X-ray CT detectors" at ¶ 0073) and on said plurality of said second images ("PET images" at ¶0075) and said associated plurality of second movement (Fig. 11B; "internal organ movement" at abstract and ¶ 0101) measurements (Fig. 2b-14; "PET tomograph detectors" at ¶ 0073),

wherein the first imaging technique ("X-ray CT" at ¶¶ 0070 and 0073) is different from the second imaging technique ("PET" at ¶¶ 0070 and 0073; "The first imaging technique is a X-ray CT that is different with the second imaging technique, which is a PET.") .

b. Regarding claim 16, Townsend discloses further comprising:

time-synchronizing said first movement (Fig. 11A; "internal organ movement" at abstract and ¶ 0101) measurements (Fig. 2b-12; "X-ray CT detectors" at ¶ 0073) and

said second movement (Fig. 11B; “internal organ movement” at abstract and ¶ 0101) measurements(Fig. 2b-14; “PET tomograph detectors” at ¶ 0073; “The invention shows that synchronization, which “the CT scan is acquired before the PET scan, following a sixty (60) minute uptake period F-FDG activity has been injected into the patient”” at ¶ 0075).

c. Regarding claim 17, Townsend discloses further comprising:

forming first reconstructed images corresponding to said plurality of first images (“[t]he CT images [being] reconstructed" at ¶ 0075) and second reconstructed images corresponding to said plurality of second images (“the PET images [being] then reconstructed” ¶ 0075).

d. Regarding claim 18, Townsend discloses further comprising:

spatially-synchronizing (“image fusion” at ¶ 0080) said first reconstructed images and said second reconstructed images (”fused PET and CT images" at ¶ 0080).

e. Regarding claim 19, Townsend discloses wherein said first imaging technique being a radiation attenuation technique (“X-ray CT” at ¶¶ 0070 and 0073) and said second imaging technique being a radiation emission technique (“PET” at ¶¶ 0070 and 0073).

f. Regarding claim 20, Townsend discloses further comprising:

spatially-synchronizing information (“positional correspondence between the two image sets" at ¶ 0080) based on said plurality of first movement (Fig. 11A; “internal organ movement” at abstract and ¶ 0101) measurements (Fig. 2b-12; “X-ray CT detectors” at ¶ 0073) and information based on said plurality of second movement (Fig.

11B; "internal organ movement" at abstract and ¶ 0101) measurements (Fig. 2b-14; "PET tomograph detectors" at ¶ 0073).

g. Regarding claim 25, Townsend discloses wherein said plurality of first movement (Fig. 11A; "internal organ movement" at abstract and ¶ 0101) measurements (Fig. 2b-12; "X-ray CT detectors" at ¶ 0073) and said plurality of second movement (Fig. 11B; "internal organ movement" at abstract and ¶ 0101) measurements (Fig. 2b-14; "PET tomograph detectors" at ¶ 0073) are taken using separate measurement systems (Figs. 2b-12 and 2b-14; "X-ray CT detectors and PET tomograph detectors are different measurements in separate gantries" at ¶ 0073) respectively associated with separate imaging systems (Figs. 2b-12, 2b-14, 16A and 16b; "X-ray CT detectors are disposed in gantry 16A and PET tomograph detectors are disposed in gantry 16B. Gentries 16A and 16B are separate platforms." at ¶ 0073) used to obtain said plurality of first images ("CT images" at ¶ 0075) and said plurality of second images ("PET images" at ¶0075).

h. Regarding claim 26, claim 26 is a system claim analogous and corresponds to claim 15. See rejection of claim 15 for further explanation.

i. Regarding claim 27, claim 27 is a system claim analogous and corresponds to claim 17. See rejection of claim 17 for further explanation.

j. Regarding claim 28, claim 28 is a system claim analogous and corresponds to claim 19. See rejection of claim 19 for further explanation.

k. Regarding claim 33, claim 33 is a system claim analogous and corresponds to claim 15. See rejection of claim 15 for further explanation.

l. Regarding claim 34, claim 34 is a system claim analogous and corresponds to claim 15. See rejection of claim 15 for further explanation.

Claim Rejections - 35 USC § 103

8. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

9. Claims 21-23 and 29-31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Townsend et al. (US 2003/0004405 A1) in view of Acar et al. (US 2004/0141638 A1).

a Regarding claim 21, Townsend discloses all the previous claim limitations including said plurality of first images ("CT images" at ¶ 0075), said plurality of first movement (Fig. 11A; "internal organ movement" at abstract and ¶ 0101) measurements (Fig. 2b-12; "X-ray CT detectors" at ¶ 0073), said plurality of second images ("PET images" at ¶0075) and said plurality of second movement (Fig. 11B; "internal organ movement" at abstract and ¶ 0101) measurements (Fig. 2b-14; "PET tomograph detectors" at ¶ 0073).

However, Townsend does not disclose forming displacement fields.

Instead of Townsend, Acar, the same field of medical image processing discloses forming displacement fields (equation (1); FIG. 1; "It is shown that the EDF, "$v_{z=k}$ (x,y)" is computed from z=k to z=k+1" at ¶¶ 0013-0014 and 0015-0017).

Townsend and Acar are combinable because both are related to the field of medical image processing.

It would have been obvious at the tie the invention was made to one of the ordinary skill in the art to utilize the step of computing "EDF, $v_{z=k}$ (x,y) from z=k to z=k+1" (Acar; equation (1); FIG.1; ¶¶ 0013-0014 and 0015-0017) taught by Acar to the plurality of first images (Townsend; "CT images" at ¶ 0075) obtained by the plurality of first measurements (Townsend; Fig. 2b-12; "X-ray CT detectors" at ¶ 0073) and to the plurality of second images ("PET images" at ¶0075) obtained by the plurality of second measurements (Fig. 2b-14; "PET tomograph detectors" at ¶ 0073) of Townsend's "PET/CT scanner" (Townsend; FIG. 2B; ¶ 0073).

The suggestion/motivation for doing so would have been to "characteriz[e] the topology of the vector field for detection, identification or recognition tasks of a structure of interest" (Acar; ¶ 0006) "with a high specificity without sacrificing the sensitivity of detection" (Acar; ¶ 0006).

Therefore, it would have been obvious to combine Townsend and Acar to obtain the invention specified in claim 21.

b. Regarding claim 22, the combination of Townsend and Acar, as applied in claim 21, discloses all the previous claim limitations including said forming an image (Townsend; Fig.3; "image fusion" at ¶ 0080) of the mobile object (Townsend; Fig. 2b; "patient" at ¶¶ 0070 and 0073).

Moreover, Acar discloses combining said displacement fields (FIG. 1; "$v_{z=k}$ (x,y) for all k are summed ,,, to get a composite EDF" at ¶ 0017).

Townsend and Acar are combinable because both are related to the field of medical image processing.

It would have been obvious at the tie the invention was made to one of the ordinary skill in the art to utilize the step of computing "$v_{z=k}$ (x,y) for all k being summed ,,, to get a composite EDF" (Acar; FIG.1; ¶ 0017) taught by Acar to the step of forming an image (Townsend; Fig.3; "image fusion" at ¶ 0080) of the mobile object (Townsend; Fig. 2b; "patient" at ¶¶ 0070 and 0073) of the combination of Townsend and Acar.

The suggestion/motivation for doing so would have been to "determine parameters … [which] are used to classify the structure of interest" (Acar; ¶ 0007) and "refine the results of high sensitivity, low specificity pre-detection by increasing specificity without sacrificing sensitivity" (Acar; ¶ 0013).

Therefore, it would have been obvious to combine Townsend and Acar to obtain the invention specified in claim 22.

c. Regarding claim 23, the combination of Townsend and Acar, as applied in claim 21, discloses wherein said forming displacement fields (Acar; equation (1); FIG. 1; "It is shown that the EDF, "$v_{z=k}$ (x,y)" is computed from z=k to z=k+1" at ¶¶ 0013-0014 and 0015-0017) comprises:

estimating movement (Acar; equation (1); "EDF computation to represent the changes in the location of edges" at ¶ 0015) of the mobile object (Acar; "images such as tissue/air boundaries" at ¶ 0015) based, respectively, on said plurality of first images (Townsend; "CT images" at ¶ 0075), said plurality of second images (Townsend; "PET images" at ¶0075), said plurality of first movement (Townsend; Fig. 11A; "internal organ

movement" at abstract and ¶ 0101) measurements (Townsend; Fig. 2b-12; "X-ray CT detectors" at ¶ 0073), and said plurality of second movement (Townsend; Fig. 11B; "internal organ movement" at abstract and ¶ 0101) measurements (Townsend; Fig. 2b-14; "PET tomograph detectors" at ¶ 0073), in order to form said displacement fields (Acar; equation (1); FIG. 1; "It is shown that the EDF, "$v_{z=k}$ (x,y)" is computed from z=k to z=k+1" at ¶¶ 0013-0014 and 0015-0017).

d. Regarding claim 29, claim 29 is analogous and corresponds to claim 21. See rejection of claim 21 for further explanation.

e. Regarding claim 30, claim 30 is analogous and corresponds to claim 22. See rejection of claim 22 for further explanation.

f. Regarding claim 31, claim 31 is analogous and corresponds to claim 23. See rejection of claim 23 for further explanation.

10. Claims 24 and 32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Townsend et al. (US 2003/0004405 A1) in view of Acar et al. (US 2004/0141638 A1), and further in view of Perona et al. ("Scale-Space and Edge Detection Using Anisotropic Diffusion").

a. Regarding claim 24, the combination of Townsend and Acar, as applied in claim 23, discloses all the previous claim limitations including wherein at least one of said movement estimates (Acar; equation (1); "EDF computation to represent the changes in the location of edges" at ¶ 0015).

However, the combination of Townsend and Acar does not disclose the estimates being formed relative to a reference time.

Instead of the combination of Townsend and Acar, Perona, the same field of endeavor of image processing, discloses the estimates being formed relative to a reference time (equation (1); “It is shown that I (x, y, t) is obtained by convolving the original image I_o (x,y) with a Gaussian kernel G (x,y; t) of variance t, which can be the reference time” at chapter I, page 629)

Townsend, Acar and Perona are combinable because all of them are related to the field of image processing.

It would have been obvious at the time the invention was made one of ordinary skill in the art to utilize the step of “I (x, y, t) [being] obtained by convolving the original image I_o (x,y) with a Gaussian kernel G (x,y; t) of variance t", which can be the reference time (Perona; equation (1); chapter I, page 629) taught by Perona to the “EDF computation [] [representing] the changes in the location of edges” (Acar; ¶ 0015) when "[t]he EDF equation for the xy plane is $\nabla I_{z=k} \cdot v_{z=k} + \frac{\partial I_{z=k}}{\partial z} = 0$" (Acar; equation (1); ¶ 0016) and "$I_{z=k}(x, y)$ is the associate image" (Acar; ¶ 0017) of the combination of Townsend and Acar.

The suggestion/motivation for doing so would have been to provide "[c]ausality [,] [which] [a]ny feature at a coarse level of resolution is required to possess (not a necessarily unique) "cause" at a finer level of resolution" (Perona; chapter 1, page 629) and "no spurious detail should be generated when the resolution is diminished"

(Perona; chapter 1, page 629), "[h]omogenity [and] [i]sotropy … for the sake of simplicity" (Perona; chapter 1, page 629).

Therefore, it would have been obvious to combine Townsend, Acar and Perona to obtain the invention specified in claim 24.

b. Regarding claim 32, claim 32 is analogous and corresponds to claim 24. See rejection of claim 24 for further explanation.

Conclusion

11. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

12. The prior art made of record is considered pertinent to the disclosure of the application:

- Summers et al. (US 6,246,784 B1): A region growing method segments three-dimensional image data of an anatomical structure using a tortuous path length limit to constrain voxel growth. The path length limit constrains the number of successive generations of voxel growth from a seed point to prevent leakage of voxels outside the boundary of the anatomical structure. Once segmented, a process for detecting surface anomalies performs a curvature analysis on a computer model of the surface of the structure. This process detects surface anomalies automatically by traversing the vertices in the surface model, computing partial derivatives of the surface at the vertices, and computing curvature characteristics from the partial derivatives. To identify possible anomalies, the process compares the curvature characteristics with predetermined curvature characteristics of anomalies and classifies the vertices. The process further refines potential anomalies by segmenting neighboring vertices that are classified as being part of an anomaly using curvature characteristics. Finally, the process colorizes the anomalies and computes a camera position and direction for each one to assist the user in viewing 2D renderings of the computer model.
- Wilk et al. (US 2003/0212320): A method of determining linear and angular displacements of a first coordinate system of a field of view of a first imaging system relative to a second a coordinate system of a field of view of a second imaging system, the method comprising: providing a phantom having a plurality of fiducial regions that can be imaged by both imaging systems; acquiring first

and second images of the phantom with the first and second imaging systems wherein spatial coordinates of features in the first and second images reference the first and second coordinate systems respectively; determining positions of a plurality of features of the fiducials in the first image and spatial coordinates of the same features in the second image; and using the coordinates to determine the linear and angular displacements.

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to JOHN Wahnkyo LEE whose telephone number is (571)272-9554. The examiner can normally be reached on Monday - Friday (Alt.) 7:30 a.m. - 5:00 p.m..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Samir Ahmed can be reached on (571) 272-7413. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO

Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/John Wahnkyo Lee/
Examiner, Art Unit 2624

/Brian Q Le/
Primary Examiner, Art Unit 2624

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	96	"6490476"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:10
S2	5	09/685222	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:11
S3	6	"6527090"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:15
S4	41	"5124914"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:18

S5	5	"5333107"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:18
S6	1	07/788179	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:18
S7	9	"5408511"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:19
S8	8	"5475726"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:19
S9	4	"5406478"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:19
S10	1	08/249993	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:20

S11	9	"5444792"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:21
S12	6	"5814817"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:21
S13	0	08/667879	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:22
S14	6	"5889525"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:22
S15	5	"5933517"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:24
S16	5	"6103350"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:24

S17	2	"6920240"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:24
S18	4	"6888915"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:25
S19	2593	(bonnet-stephane.in. or bonnet.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:51
S20	96	(grangeat-pierre.in. or grangeat.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:51
S21	2686	S19 or S20	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:51
S22	283800	(mobile or techinque or measurement).clm.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:52

S23	54	S21 and S22	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:52
S25	2	"20040004405"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 00:08
S28	6918	382/128.ccls. or 345/420.ccls. or 600/427.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 00:09
S29	1	10/955037	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 00:19
S30	0	(displacement near3 fields) near3 PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:56
S31	8	(displacement near3 fields) near3 CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:56

S32	3	(displacement near3 fields) with PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S33	18	(displacement near3 fields) with CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S34	1	S32 and S33	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S35	8931	(displacement near3 fields)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S36	81	S35 and CT and PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S37	18	S36 and S28	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57

S38	1736832	(vector or displacement)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:06
S39	786	S38 near3 CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:07
S40	8098	S38 near3 PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:07
S41	75	S39 and S40	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:07
S42	3520	S38 with CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:07
S43	12182	S38 WITH PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:07

S44	195	S42 and S43	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:08
S45	1854	vector with CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:38
S46	11867	vector with PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:39
S47	181	S45 and S46	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:39
S48	504	gradient with CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:40
S49	425	gradient WITH PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:40

S50	11	S48 and S49	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:40
S51	4636	motion with CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:46
S52	1522	motion WITH PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:46
S53	164	S51 and S52	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:46
S54	54	S53 and vector	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:54
S55	79	S53 and (vector or displacement)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:54

S56	15542	displacement near3 (field or vector)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:36
S57	150	S56 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:36
S58	19316809	combin$3 or form$3 or fus$3	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:38
S59	13665	S56 and S58	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:39
S60	1486	S59 and medical	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:39
S61	144	S59 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:39

S62	994101	S58 near3 image	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:41
S63	3025	S62 and S56	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:42
S64	88	S63 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:42
S65	107	S56 with S62	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:54
S66	2	S65 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:54
S67	3	S65 and (x-ray and CT)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:56

S68	112890	goto.in.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:59
S69	59266	hitachi.asnm.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:59
S70	0	S68 and S69 and (displacment) and vector	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:00
S71	4	S68 and S69 and (displacement) and vector	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:00
S72	17	S68 and S69 and vector	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:00
S73	1	JP2006141534A	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:02

S74	25	S65 and "382".clas.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:03
S75	16464	gradient near3 time	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:24
S76	52	S75 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:24
S77	13	S76 and (x-ray and CT)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:24
S78	100	gradient near3 (reference near3 time)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:30
S79	0	S78 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:30

S80	4	S78 and (x-ray and CT)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:30
S81	0	S78 and "382".clas.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:31
S82	4551	total near3 derivative	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:33
S83	7	S82 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:33
S84	569	vector near3 (reference near3 time)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:35
S85	3	S84 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:35

S87	16464	gradient near3 time	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:37
S88	52	S87 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:37
S89	22	"5963665"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/08 21:22
S90	11431	(commissariat$5.asnm. or intellectual$7.asnm.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:52
S91	2593	(bonnet-stephane.in. or bonnet.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:52
S92	96	(grangeat-pierre.in. or grangeat.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:52

S93	2686	S91 or S92	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:52
S94	30	S90 and S93	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:52
S95	284977	(mobile or techinque or measurement).clm.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:53
S96	17	S94 and S95	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:53

1/12/2011 9:37:34 AM
C:\Documents and Settings\jlee15\My Documents\EAST\Workspaces\10955037 partial.wsp

PTO/SB/30 (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
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Request for Continued Examination (RCE) Transmittal

Address to:
Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Application Number	10/955,037-Conf. #4535
Filing Date	September 30, 2004
First Named Inventor	Stephane Bonnet
Art Unit	2624
Examiner Name	J. W. Lee
Attorney Docket Number	27592-00987-US

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.

Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. See Instruction Sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. Submission required under 37 CFR 1.114 Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

   a. [ ] Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.
      i. [ ] Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
      ii. [ ] Other _____

   b. [x] Enclosed
      i. [x] Amendment/Reply
      ii. [ ] Affidavit(s)/Declaration(s)
      iii. [ ] Information Disclosure Statement (IDS)
      iv. [ ] Other _____

2. Miscellaneous

   a. [ ] Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of _____ months. (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

   b. [ ] Other _____

3. Fees The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.

   a. [x] The Director is hereby authorized to charge the following fees, any underpayment of fees, or credit any Overpayments, to Deposit Account No. 22-0185 .
      i. [ ] RCE fee required under 37 CFR 1.17(e)
      ii. [ ] Extension of time fee (37 CFR 1.136 and 1.17)
      iii. [ ] Other _____

   b. [ ] Check in the amount of $ _____ enclosed

   c. [x] Payment by credit card (Form PTO-2038 enclosed)

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

Signature	/DMMorse/	Date	March 8, 2011
Name (Print/Type)	David M. Morse	Registration No.	50,505

4227830

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Stephane Bonnet et al.

Application No.: 10/955,037 Confirmation No.: 4535

Filed: September 30, 2004 Art Unit: 2624

For: Method of reconstructing an image with data acquisition according to several imagery modes and synchronisation of image series Examiner: J. W. Lee

**RESPONSE TO FINAL OFFICE ACTION
FILED UNDER 37 CFR § 1.114
AND
INTERVIEW SUMMARY**

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Applicants hereby respond to the Final Office Action mailed January 13, 2011. This paper is being submitted under 37 CFR 1.114 as part of a Request for Continued Examination.

A listing of the claims, including amendments thereto, begins on page 2 of this paper.

Remarks begin on page 7 of this paper.

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
10/955,037	09/30/2004	

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)	SMALL ENTITY ☐ RATE ($)	SMALL ENTITY ☐ FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
FOR	NUMBER FILED	NUMBER EXTRA					
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT 03/08/2011

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 18	Minus	** 20	= 0	X $ =		OR	X $52=	0
Independent (37 CFR 1.16(h))	* 2	Minus	***4	= 0	X $ =		OR	X $220=	0
☐ Application Size Fee (37 CFR 1.16(s))									
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	0

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =		OR	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =		OR	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))									
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/LASHAWN MARKS/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Patent Application Fee Transmittal	
Application Number:	10955037
Filing Date:	30-Sep-2004
Title of Invention:	Method of reconstructing an image with data acquisition according to several imagery modes and synchronisation of image series
First Named Inventor/Applicant Name:	Stephane Bonnet
Filer:	David M. Morse/Renee Conti
Attorney Docket Number:	27592-00987- US
Filed as Large Entity	

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Request for continued examination	1801	1	810	810
		Total in USD ($)		**810**

Electronic Acknowledgement Receipt	
EFS ID:	9610251
Application Number:	10955037
International Application Number:	
Confirmation Number:	4535
Title of Invention:	Method of reconstructing an image with data acquisition according to several imagery modes and synchronisation of image series
First Named Inventor/Applicant Name:	Stephane Bonnet
Customer Number:	30678
Filer:	David M. Morse/Renee Conti
Filer Authorized By:	David M. Morse
Attorney Docket Number:	27592-00987- US
Receipt Date:	08-MAR-2011
Filing Date:	30-SEP-2004
Time Stamp:	14:25:03
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$810
RAM confirmation Number	696
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Request for Continued Examination (RCE)	RCE.pdf	65555 ff6c803b3dfdb1b953df8ee0ae33ab2ebbbb637b	no	1
Warnings:					
This is not a USPTO supplied RCE SB30 form.					
Information:					
2		Response_to_Final_Office_Action_and_Interview_Summary.pdf	108659 cb82cc991dc62abcd27607343fe6cb006db06543	yes	12
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Amendment Submitted/Entered with Filing of CPA/RCE		1	1	
	Claims		2	6	
	Applicant Arguments/Remarks Made in an Amendment		7	12	
Warnings:					
Information:					
3	Fee Worksheet (PTO-875)	fee-info.pdf	30159 1e6d164fae672442cb1a8e6352d9260b651d5574	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	204373		

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

LISTING OF THE CLAIMS

Applicants hereby present the claims, their status in the application, and amendments thereto as indicated below. This listing of the claims replaces all prior versions and listings of the claims in this application.

1.-14. (Cancelled)

15. (Currently Amended) A method of forming an image of a mobile object, comprising:

obtaining a plurality of first images of the mobile object using a first imaging technique ~~and an associated~~ while obtaining a plurality of first ~~movement~~ measurements corresponding to movements of the mobile object using a first sensor system, the first sensor system being independent from the first imaging technique ~~at movement states corresponding to movement states of said plurality of first images~~;

associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements;

obtaining a plurality of second images of the mobile object using a second imaging technique ~~and an associated~~ while obtaining a plurality of second ~~movement~~ measurements corresponding to movements of the mobile object using a second sensor system, the second sensor system being independent from the second imaging technique ~~at movement states corresponding to movement states of said plurality of second images, wherein the plurality of second movement measurements are distinct from the plurality of first movement measurements~~;

associating the plurality of second images with second movement states of the mobile object, the second movement states being determined by the second measurements; and

forming an image of the mobile object based on said plurality of first images, ~~and~~ said associated plurality of first ~~movement~~ measurements, and said first movement states and on said plurality of ~~said~~ second images, ~~and~~ said associated plurality of second ~~movement~~ measurements, and said second movement states,

wherein the first imaging technique is different from the second imaging technique.

16. (Currently Amended) The method of Claim 15, further comprising:

time-synchronizing said first plurality of images and said second plurality of images to a common time scale, the common time scale being determined by a comparison between the first and second movement states ~~said first movement measurements and said second movement measurements~~.

17. (Previously Presented) The method of Claim 15, further comprising:

forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images.

18. (Previously Presented) The method of Claim 17, further comprising:

spatially-synchronizing said first reconstructed images and said second reconstructed images.

19. (Previously Presented) The method of Claim 15, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique.

20. (Currently Amended) The method of Claim 15, further comprising:

spatially-synchronizing the plurality of first images and the plurality of second images using ~~information based on~~ said plurality of first ~~movement~~ measurements and ~~information based on~~ said plurality of second ~~movement~~ measurements.

21. (Currently Amended) The method of Claim 15, further comprising:

forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first ~~movement~~ measurements, said plurality of second images, and said plurality of second ~~movement~~ measurements.

22. (Previously Presented) The method of Claim 21, wherein said forming an image of the mobile object comprises combining said displacement fields.

23. (Currently Amended) The method of Claim 21, wherein said forming displacement fields comprises:

estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first ~~movement~~ measurements, and said plurality of second ~~movement~~ measurements, in order to form said displacement fields.

24. (Previously Presented) The method of Claim 23, wherein at least one of said movement estimates is formed relative to a reference time.

25. (Currently Amended) The method of Claim 15, wherein the first sensor system is different from the second sensor system ~~said plurality of first movement measurements and said plurality of second movement measurements are taken using separate measurement systems respectively associated with separate imaging systems used to obtain said plurality of first images and said plurality of second images~~.

26. (Currently Amended) An apparatus to form an image of a mobile object, comprising:

means for obtaining a plurality of first images of the mobile object using a first imaging technique;

means for obtaining ~~an associated~~ a plurality of first ~~movement~~ measurements corresponding to movements of the mobile object while obtaining the plurality of first images, the means for obtaining the plurality of first measurements being independent from the first imaging technique ~~at movement states corresponding to movement states of said plurality of first images~~;

means for associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements;

means for obtaining a plurality of second images of the mobile object using a second imaging technique;

means for associating the plurality of second images with second movement states of the mobile object, the second movement states being determined by the second measurements;

means for obtaining ~~an associated~~ a plurality of second ~~movement~~ measurements corresponding to movements of the mobile object while obtaining the plurality of second images, the means for obtaining the plurality of second measurements being independent from the second imaging technique ~~at movement states corresponding to movement states of said plurality of second images, wherein the plurality of second movement measurements are distinct from the plurality of first movement measurements~~; and

means for forming an image of the mobile object based on said plurality of first images, ~~and~~ said associated plurality of first ~~movement~~ measurements, and said first movement states and on said plurality of said second images, ~~and~~ said associated plurality of second ~~movement~~ measurements, and said second movement states,

wherein the first imaging technique is different from the second imaging technique.

27. (Previously Presented) The apparatus of Claim 26, further comprising:

means for forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images.

28. (Previously Presented) The apparatus of Claim 26, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique.

29. (Currently Amended) The apparatus of Claim 26, further comprising:

means for forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first ~~movement~~ measurements, said plurality of second images, and said plurality of second ~~movement~~ measurements.

30. (Previously Presented) The apparatus of Claim 29, wherein said means for forming an image of the mobile object comprises means for combining said displacement fields.

31. (Currently Amended) The apparatus of Claim 29, wherein said means for forming displacement fields comprises:

means for estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first ~~movement~~ measurements, and said plurality of second ~~movement~~ measurements, in order to form said displacement fields.

32. (Previously Presented) The apparatus of Claim 31, wherein at least one of said movement estimates is to be formed relative to a reference time.

33. (Canceled)

34. (Canceled)

REMARKS

Applicant thanks the Examiner for the careful consideration given to this application. Reconsideration is now respectfully requested in view of the amendment above and the following remarks.

Claims 15-32 are pending in this application. Claims 15 and 26 are independent claims. Claims 15, 16, 20, 21, 23, 25, 26, 29, and 31 are amended. Claims 1-14, 33, and 34 were previously cancelled without prejudice or disclaimer. Reconsideration and allowance of the present application are respectfully requested.

The amendments to claims 15 and 26 find support at least in paragraph [0013] of the published specification (the paragraph beginning on page 5, line 16 of the specification as filed) and in the claims as originally filed. The amendment to claim 16 finds support in at least paragraph [0014] of the published specification (the paragraph beginning on page 6, line 6 of the specification as filed). The amendment to claim 20 finds support in at least paragraph [0019] of the published specification (the paragraph beginning on page 8, line 6 of the specification as filed). The amendments to claims 21, 23, 29, and 31 find support in at least these same claims as originally filed.

Summary of Examiner Interview

Initially, Applicants wish to thank Examiner Lee for his time at the interview of March 7, 2011, the substance of which is summarized below.

An Interview Agenda was provided to Examiner Lee in advance of the interview. As part of that Agenda, Applicants proposed amendments to claims 15, 16, and 26. The amendments to the claims substantially reflect the proposed amendments, which were discussed during the interview vis-à-vis the Townsend reference. No agreement was reached as to the proposed amendments overcoming the anticipation rejection based on the Townsend reference.

Claim Rejections under 35 U.S.C. §102

Claims 15-20, 25-28 and 33-34 stand rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent Publication No. 2003/0004405 in the names of Townsend et al. (hereinafter “Townsend”).

Anticipation requires that the cited reference disclose each and every limitation of the rejected claim. Townsend does not disclose all the limitations of amended claim 15. In particular, while Townsend discloses two imaging techniques, it does not disclose the first and second sensor systems that are independent from the first and second imaging techniques, respectively, nor does it disclose "obtaining a plurality of first images of the mobile object using a first imaging technique *while obtaining* a plurality of first measurements" or "obtaining a plurality of second images of the mobile object using a second imaging technique while obtaining a plurality of second measurements". Townsend also does not disclose "associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements" or "associating the plurality of second images with second movement states of the mobile object, the second movement states being determined by the second measurements".

Townsend discloses obtaining two sets of images, one from a CT scanning technique and the other from a PET imaging technique, and combining the two sets of images through what is described as "image fusion". (*See* Townsend, [0080].) Townsend provides an overview of the disclosed image "fusion" process:

> "The tomograph acquires functional and anatomical images which are accurately co-registered, without the use of external markers or internal landmarks. A secondary objective is to use the CT data to improve the correction of the PET data for attenuation and for contamination from scattered photons. By using the CT image in this manner, low-noise attenuation correction factors for PET are generated, and by integrating the anatomical information from the CT into scatter correction methods, an accurate scatter correction is obtained." (Townsend, [0036].)

In addition, Townsend specifically addresses how images of a mobile object are obtained and processed during the image fusion process. Specifically, Townsend discloses using a spiral CT scan to overcome the problems of obtaining images of a mobile object for the CT scanning technique. Townsend also discloses that the PET scan is taken over a period of 5-10 minutes, so that "during the scan … the resulting PET image is an integration over the respiratory and cardiac cycles." (Townsend,

[0109]). For each scanning technique, Townsend does not disclose obtaining measurements from an independent sensor system while obtaining the scan images.

Therefore, it follows that nowhere does Townsend disclose a first sensor system that is independent from the first imaging technique nor a second sensor system that is independent from the second imaging technique. Likewise, since the first and second sensor systems are not disclosed, Townsend also does not disclose obtaining the plurality of first images of the mobile object (using the first imaging technique) while obtaining the first measurements corresponding to movements of the mobile object (using the first sensor system), nor does it disclose obtaining the plurality of second images of the mobile object (using the second imaging technique) while obtaining the second measurements corresponding to movements of the mobile object (using the second sensor system). Consequently, Townsend also does not disclose "associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements" or "associating the plurality of second images with second movement states of the mobile object, the second movement states being determined by the second measurements". For these reasons, Townsend does not anticipate amended claim 15.

Claim 16 was also rejected as anticipated by Townsend, and this claim depends from claim 15. As amended, claim 16 recites "time-synchronizing said first plurality of images and said second plurality of images to a common time scale, the common time scale being determined by a comparison between the first and second movement states." Townsend does not disclose time-synchronizing in this manner. The Office Action indicates that Townsend discloses time-synchronization when "the CT scan is acquired before the PET scan, following a sixty (60) minute uptake period F-FDG activity has been injected into the patient". (Quoting ¶ 75 of Townsend.) However, even if this sequence described in Townsend is, *arguendo*, time-synchronization, Townsend does not disclose time-synchronization to a common time scale that is "determined by a comparison between the first and second movement states." For this further reason, Townsend does not anticipate amended claim 16.

Claim 26 as amended includes limitations that are analogous to those found in amended claim 15. For the same reasons stated above with respect to amended claim 15, Townsend does not anticipate amended claim 26.

Each of claims 17-20, 25, 27, 28, and 33-34 ultimately depends from one of claims 15 and 26. Where, as discussed above, Townsend does not anticipate either of amended claims 15 or 26, Townsend also does not anticipate any of these dependent claims.

For these reasons, Applicants respectfully request withdrawal of the rejection of claims 15-20, 25-28 and 33-34 under 35 U.S.C. §102.

Claim Rejections Under 35 U.S.C. §103

Claims 21-23 and 29-31 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Townsend in view of U.S. Patent Publication No. 2004/0141638 in the names of Acar et al. (hereinafter "Acar").

Each of claims 21-23 and 29-31 ultimately depends from one of claims 15 and 26. As is discussed above, Townsend does not disclose all the limitations of amended claims 15 and 26. Acar fails to teach or disclose those features that are not disclosed by Townsend. Therefore, the combination of Townsend and Acar fails to teach or disclose all the limitations of claims 21-23 and 29-31. For this reason, Applicants respectfully request withdrawal of the rejection of claims 21-23 and 29-31 under 35 U.S.C. §103.

Claims 24 and 32 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Townsend et al. in view of Acar et al., and in further view of "Scale-Space and Edge Detection Using Anisotropic Diffusion" by Perona et al. (hereinafter "Perona"). Each of claims 24 and 32 ultimately depends from one of claims 15 and 26. As is indicated above, the combination of Townsend and Acar does not teach or disclose all the limitations of amended claims 15 and 26. Perona fails to teach or disclose those features that are not disclosed by Townsend and Acar. Therefore, the combination of Townsend, Acar, and Perona fails to teach or disclose all the limitations of claims 24 and 32. For this reason, Applicants respectfully request withdrawal of rejection of claims 24 and 32 under 35 U.S.C. §103.

Disclaimer

Applicants may not have presented all possible arguments or have refuted the characterizations of either the claims or the prior art as found in the Office Action. However, the lack of such arguments or refutations is not intended to act as a waiver of such arguments or as concurrence with such characterizations.

CONCLUSION

In view of the above, reconsideration and allowance are respectfully solicited.

In the event the Examiner believes an interview might serve in any way to advance the prosecution of this application, the undersigned is available at the telephone number noted below.

Applicants believe no extensions or fees are due with this response. However, if an extension is needed or a fee is due, please consider this a request therefor and charge Deposit Account No. 22-0185, under Order No. 27592-00987-US, from which the undersigned is authorized to draw.

Dated: March 8, 2011

Respectfully submitted,

CONNOLLY BOVE LODGE & HUTZ LLP

Electronic signature: /DMMorse/
David M. Morse
Registration No.: 50,505

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/955,037	09/30/2004	Stephane Bonnet	27592-00987- US	4535

30678 7590 03/09/2011
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1875 EYE STREET, N.W.
SUITE 1100
WASHINGTON, DC 20006

EXAMINER	
LEE, JOHN W	
ART UNIT	PAPER NUMBER
2624	

MAIL DATE	DELIVERY MODE
03/09/2011	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Interview Summary	Application No.	Applicant(s)	
	10/955,037	BONNET ET AL.	
	Examiner	Art Unit	
	JOHN W. LEE	2624	

All participants (applicant, applicant's representative, PTO personnel):

(1) *JOHN W. LEE*. (3)*Jefferson Cheatham*.

(2) *David M. Morse*. (4)_____.

Date of Interview: *07 March 2011*.

Type: a)☒ Telephonic b)☐ Video Conference
c)☐ Personal [copy given to: 1)☐ applicant 2)☐ applicant's representative]

Exhibit shown or demonstration conducted: d)☐ Yes e)☒ No.
If Yes, brief description: _____.

Claim(s) discussed: *15,16 and 26*.

Identification of prior art discussed: *Towsend et al.*.

Agreement with respect to the claims f)☐ was reached. g)☒ was not reached. h)☐ N/A.

Substance of Interview including description of the general nature of what was agreed to if an agreement was reached, or any other comments: *The applicant's representative argued that (1)Townsend does not have a speparate sensors from the imaging technique, which is different with the proposed amended claims 15 and 26 (2) does not use a common-time scale as part of the synchorinzation as it is specified in the proposed amended claim 16*.

(A fuller description, if necessary, and a copy of the amendments which the examiner agreed would render the claims allowable, if available, must be attached. Also, where no copy of the amendments that would render the claims allowable is available, a summary thereof must be attached.)

THE FORMAL WRITTEN REPLY TO THE LAST OFFICE ACTION MUST INCLUDE THE SUBSTANCE OF THE INTERVIEW. (See MPEP Section 713.04). If a reply to the last Office action has already been filed, APPLICANT IS GIVEN A NON-EXTENDABLE PERIOD OF THE LONGER OF ONE MONTH OR THIRTY DAYS FROM THIS INTERVIEW DATE, OR THE MAILING DATE OF THIS INTERVIEW SUMMARY FORM, WHICHEVER IS LATER, TO FILE A STATEMENT OF THE SUBSTANCE OF THE INTERVIEW. See Summary of Record of Interview requirements on reverse side or on attached sheet.

/JOHN W. LEE/ Examiner, Art Unit 2624	

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews
Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

———

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:
1) A brief description of the nature of any exhibit shown or any demonstration conducted,
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

Notice of References Cited	Application/Control No. 10/955,037	Applicant(s)/Patent Under Reexamination BONNET ET AL.	
	Examiner JOHN LEE	Art Unit 2624	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-4,694,156 A	09-1987	Swanberg, Melvin E.	250/214RC
*	B	US-5,621,532 A	04-1997	Ooki et al.	356/444
*	C	US-5,889,525 A	03-1999	De Murcia et al.	345/420
*	D	US-6,246,784 B1	06-2001	Summers et al.	382/128
*	E	US-2003/0004405 A1	01-2003	Townsend et al.	600/407
*	F	US-2003/0212320 A1	11-2003	Wilk et al.	600/407
*	G	US-2004/0105575 A1	06-2004	Ganz et al.	382/128
*	H	US-2004/0141638 A1	07-2004	Acar et al.	382/131
*	I	US-2004/0175832 A1	09-2004	Hui et al.	436/008
*	J	US-6,885,702 B1	04-2005	Goudezeune et al.	375/240.12
*	K	US-2007/0177778 A1	08-2007	Massaro, Peter	382/128
*	L	US-7,695,683 B2	04-2010	Quan et al.	422/504
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	10955037	BONNET ET AL.
	Examiner	Art Unit
	Lee, John W	2112

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/27/2006	09/07/2007	05/25/2008	11/07/2008	04/22/2009	11/20/2009	07/09/2010	01/12/2011	07/05/2011
	1	✓	-	-	-	-	-	-	-	-
	2	✓	-	-	-	-	-	-	-	-
	3	✓	-	-	-	-	-	-	-	-
	4	✓	-	-	-	-	-	-	-	-
	5	✓	-	-	-	-	-	-	-	-
	6	✓	-	-	-	-	-	-	-	-
	7	✓	-	-	-	-	-	-	-	-
	8	✓	-	-	-	-	-	-	-	-
	9		✓	-	-	-	-	-	-	-
	10		✓	-	-	-	-	-	-	-
	11		✓	-	-	-	-	-	-	-
	12		✓	-	-	-	-	-	-	-
	13		✓	-	-	-	-	-	-	-
	14		✓	-	-	-	-	-	-	-
	15			✓	✓	✓	✓	✓	✓	✓
	16			✓	✓	✓	✓	✓	✓	✓
	17			✓	✓	✓	✓	✓	✓	✓
	18			✓	✓	✓	✓	✓	✓	✓
	19			✓	✓	✓	✓	✓	✓	✓
	20			✓	✓	✓	✓	✓	✓	✓
	21			✓	✓	✓	✓	✓	✓	✓
	22			✓	✓	✓	✓	✓	✓	✓
	23			✓	✓	✓	✓	✓	✓	✓
	24			✓	✓	✓	✓	✓	✓	✓
	25			✓	✓	✓	✓	✓	✓	✓
	26			✓	✓	✓	✓	✓	✓	✓
	27			✓	✓	✓	✓	✓	✓	✓
	28			✓	✓	✓	✓	✓	✓	✓
	29			✓	✓	✓	✓	✓	✓	✓
	30			✓	✓	✓	✓	✓	✓	✓
	31			✓	✓	✓	✓	✓	✓	✓
	32			✓	✓	✓	✓	✓	✓	✓
	33								✓	-
	34								✓	-

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	10955037	BONNET ET AL.
	Examiner	Art Unit
	Lee, John W	2112

SEARCHED			
Class	Subclass	Date	Examiner
382	128	12/26/2006	John W. Lee
345	420	12/26/2006	John W. Lee
382	128	11/06/2008	John W. Lee

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor Search	12/26/2006	John W. Lee
East Search	12/26/2006	John W. Lee
IEEE (Non- Patent Literature Search)	12/26/2006	John W. Lee
EAST Search	11/06/2008	John W. Lee
EAST Search	4/22/2009	John W. Lee
EAST Search	11/20/2009	John W. Lee
Inventor Search (using EDAN)	7/9/2010	John W. Lee
Inventor Search (using EAST)	7/9/2010	John W. Lee
Assignee Search (using EAST)	7/9/2010	John W. Lee
EAST Search	7/1/2010	John W. Lee
Plus Search	7/6/2010	John W. Lee
NPL search (using google)	7/5/2010	John W. Lee
382/128, 345/420 and 600/427 (combined with keyword search)	7/1/2010	John W. Lee
EAST Search	1/12/2011	John W. Lee
EAST Search	7/4/2011	John W. Lee

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner

/JOHN W LEE/ Examiner.Art Unit 2624	

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/955,037	09/30/2004	Stephane Bonnet	27592-00987- US	4535

30678 7590 07/07/2011
CONNOLLY BOVE LODGE & HUTZ LLP
1875 EYE STREET, N.W.
SUITE 1100
WASHINGTON, DC 20006

EXAMINER	
LEE, JOHN W	
ART UNIT	PAPER NUMBER
2624	

MAIL DATE	DELIVERY MODE
07/07/2011	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/955,037	BONNET ET AL.	
	Examiner	Art Unit	
	JOHN LEE	2624	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *08 March 2011*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-34* is/are pending in the application.

4a) Of the above claim(s) *1-14 and 32-34* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *15-31* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 8 March 2011 has been entered.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

3. Claims 15-32 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. The amended limitations in claims 15-32- “obtaining a plurality of first images of the mobile object using a first imaging technique while obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system, the first sensor system being independent from the first imaging

technique" and "obtaining a plurality of second images of the mobile object using a second imaging technique while obtaining a plurality of second movement measurements corresponding to movements of the mobile object using a second sensor system, the second sensor system being independent from the second imaging", are not supported by the specification.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 15-20 and 25-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Townsend et al. (US 2003/0004405 A1) in view of De Murcia et al. (US 5,889,525).

a. Regarding claim 15, Townsend discloses a method of forming an image (Fig.3; "image fusion" at ¶ 0080) of a mobile object (Fig. 2b; "patient" at ¶¶ 0070 and 0073), comprising:

obtaining a plurality of first images ("CT images" at ¶ 0075) of the mobile object (Fig. 2b; "patient" at ¶¶ 0070 and 0073) using a first imaging technique ("X-ray CT" at ¶¶ 0070 and 0073);

obtaining a plurality of second images (“PET images” at ¶0075) of the mobile object (Fig. 2b; “patient” at ¶¶ 0070 and 0073) using a second imaging technique (“PET” at ¶¶ 0070 and 0073); and

forming an image (Fig.3; “image fusion” at ¶ 0080) of the mobile object (Fig. 2b; “patient” at ¶¶ 0070 and 0073) based on said plurality of first images (“CT images” at ¶ 0075) and said associated plurality of first movement (Fig. 11A; “internal organ movement” at abstract and ¶ 0101) measurements (Fig. 2b-12; “X-ray CT detectors” at ¶ 0073) and on said plurality of said second images (“PET images” at ¶0075) and said associated plurality of second movement (Fig. 11B; “internal organ movement” at abstract and ¶ 0101) measurements (Fig. 2b-14; “PET tomograph detectors” at ¶ 0073),

wherein the first imaging technique (“X-ray CT” at ¶¶ 0070 and 0073) is different from the second imaging technique (“PET” at ¶¶ 0070 and 0073; “The first imaging technique is a X-ray CT that is different with the second imaging technique, which is a PET.”) .

However, Townsend does not disclose obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system, the first sensor system being independent from the first imaging technique;

associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements;

obtaining a plurality of second movement measurements corresponding to movements of the mobile object using a second sensor system, the second sensor system being independent from the second imaging;

associating the plurality of second images with second movement states of the mobile object, the second movement states being determined by the second measurements;

Instead of Townsend, De Murcia discloses obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system, the first sensor system being independent from the first imaging technique (Fig. 2; equation (2); col. 4, line 1-col. 5, line 18);

associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements (Fig. 2; equation (2); col. 4, line 1-col. 5, line 18);

obtaining a plurality of second movement measurements corresponding to movements of the mobile object using a second sensor system, the second sensor system being independent from the second imaging(Fig. 2; equation (2); col. 4, line 1-col. 5, line 18);

associating the plurality of second images with second movement states of the mobile object, the second movement states being determined by the second measurements(Fig. 2; equation (2); col. 4, line 1-col. 5, line 18);

Townsend and De Murcia are combinable because both are related to the field of medical image processing.

At the time the invention was made, it would have been obvious to one of the ordinary skill in the art to utilize the process of De Murcia to Townsend's invention.

The suggestion/motivation for doing so would have been to obtain "satisfactory imaging results without making the apparatus more complicated" (De Murcia; col. 2, lines 44-46).

Therefore, it would have been obvious to combine Townsend and De Murcia to obtain the invention specified in claim 15.

b. Regarding claim 16, Townsend further discloses further comprising: time-synchronizing said first plurality of images and said second plurality of images to a common time scale, the common time scale being determined by a comparison between the first and second movement states said first movement measurements and said second movement measurements ("The invention shows that synchronization, which "the CT scan is acquired before the PET scan, following a sixty (60) minute uptake period F-FDG activity has been injected into the patient"" at ¶ 0075).

c. Regarding claim 17, Townsend further discloses further comprising:

forming first reconstructed images corresponding to said plurality of first images ("[t]he CT images [being] reconstructed" at ¶ 0075) and second reconstructed images corresponding to said plurality of second images ("the PET images [being] then reconstructed" ¶ 0075).

d. Regarding claim 18, Townsend further discloses further comprising:

spatially-synchronizing (“image fusion” at ¶ 0080) said first reconstructed images and said second reconstructed images (”fused PET and CT images" at ¶ 0080).

e. Regarding claim 19, Townsend further discloses wherein said first imaging technique being a radiation attenuation technique (“X-ray CT” at ¶¶ 0070 and 0073) and said second imaging technique being a radiation emission technique (“PET” at ¶¶ 0070 and 0073).

f. Regarding claim 20, Townsend discloses further comprising:

further comprising: spatially-synchronizing the plurality of first images and the plurality of second images using information based on said plurality of first measurements and said plurality of second movement measurements (“positional correspondence between the two image sets" at ¶ 0080)

g. Regarding claim 25, De Murcia discloses wherein the first sensor system is different from the second sensor system (Fig. 2; equation (2); col. 4, line 1-col. 5, line 18).

h. Regarding claim 26, claim 26 is a system claim analogous and corresponds to claim 15. See rejection of claim 15 for further explanation.

i. Regarding claim 27, claim 27 is a system claim analogous and corresponds to claim 17. See rejection of claim 17 for further explanation.

j. Regarding claim 28, claim 28 is a system claim analogous and corresponds to claim 19. See rejection of claim 19 for further explanation.

5. Claims 21-23 and 29-31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Townsend et al. (US 2003/0004405 A1) in view of Acar et al. (US 2004/0141638 A1).

a Regarding claim 21, The combination of Townsend and De Murcia disclose all the previous claim limitations including said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements (De Murcia;Fig. 2; equation (2); col. 4, line 1-col. 5, line 18).

However, the combination does not disclose forming displacement fields.

Instead of the combination, Acar, the same field of medical image processing discloses forming displacement fields (equation (1); FIG. 1; "It is shown that the EDF, "$v_{z=k}$ (x,y)" is computed from z=k to z=k+1" at ¶¶ 0013-0014 and 0015-0017).

The combination and Acar are combinable because both are related to the field of medical image processing.

It would have been obvious at the tie the invention was made to one of the ordinary skill in the art to utilize the step of computing "EDF, $v_{z=k}$ (x,y) from z=k to z=k+1" (Acar; equation (1); FIG.1; ¶¶ 0013-0014 and 0015-0017) taught by Acar to the combination.

The suggestion/motivation for doing so would have been to "characteriz[e] the topology of the vector field for detection, identification or recognition tasks of a structure of interest" (Acar; ¶ 0006) "with a high specificity without sacrificing the sensitivity of detection" (Acar; ¶ 0006).

Therefore, it would have been obvious to combine Townsend, De Murcia and Acar to obtain the invention specified in claim 21.

b. Regarding claim 22, the combination of Townsend De Murcia and Acar, as applied in claim 21, discloses all the previous claim limitations including said forming an image (Townsend; Fig.3; "image fusion" at ¶ 0080) of the mobile object (Townsend; Fig. 2b; "patient" at ¶¶ 0070 and 0073).

Moreover, Acar discloses combining said displacement fields (FIG. 1; "$v_{z=k}$ (x,y) for all k are summed ,,, to get a composite EDF" at ¶ 0017).

Townsend, De Murcia and Acar are combinable because both are related to the field of medical image processing.

It would have been obvious at the tie the invention was made to one of the ordinary skill in the art to utilize the step of computing "$v_{z=k}$ (x,y) for all k being summed ,,, to get a composite EDF" (Acar; FIG.1; ¶ 0017) taught by Acar to the combination.

The suggestion/motivation for doing so would have been to "determine parameters … [which] are used to classify the structure of interest" (Acar; ¶ 0007) and "refine the results of high sensitivity, low specificity pre-detection by increasing specificity without sacrificing sensitivity" (Acar; ¶ 0013).

Therefore, it would have been obvious to combine Townsend, De Murcia and Acar to obtain the invention specified in claim 22.

c. Regarding claim 23, the combination of Townsend, De Murcia and Acar, as applied in claim 21, discloses wherein said forming displacement fields

(Acar; equation (1); FIG. 1; "It is shown that the EDF, "$v_{z=k}$ (x,y)" is computed from z=k to z=k+1" at ¶¶ 0013-0014 and 0015-0017) comprises:

estimating movement (Acar; equation (1); "EDF computation to represent the changes in the location of edges" at ¶ 0015) of the mobile object (Acar; "images such as tissue/air boundaries" at ¶ 0015) based, respectively, on said plurality of first images (Townsend; "CT images" at ¶ 0075), said plurality of second images (Townsend; "PET images" at ¶0075), said plurality of first measurements, and said plurality of second measurements (De Murcia; Fig. 2; equation (2); col. 4, line 1-col. 5, line 18).

d. Regarding claim 29, claim 29 is analogous and corresponds to claim 21. See rejection of claim 21 for further explanation.

e. Regarding claim 30, claim 30 is analogous and corresponds to claim 22. See rejection of claim 22 for further explanation.

f. Regarding claim 31, claim 31 is analogous and corresponds to claim 23. See rejection of claim 23 for further explanation.

6. Claims 24 and 32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Townsend et al. (US 2003/0004405 A1) in view of De Murcia et al. (US 5,889,525), and further in view of Acar et al. (US 2004/0141638 A1) and Perona et al. ("Scale-Space and Edge Detection Using Anisotropic Diffusion").

a. Regarding claim 24, the combination of Townsend De Murcia and Acar, as applied in claim 23, discloses all the previous claim limitations including

wherein at least one of said movement estimates (Acar; equation (1); "EDF computation to represent the changes in the location of edges" at ¶ 0015).

However, the combination does not disclose the estimates being formed relative to a reference time.

Instead of the combination, Perona, the same field of endeavor of image processing, discloses the estimates being formed relative to a reference time (equation (1); "It is shown that I (x, y, t) is obtained by convolving the original image I_0 (x,y) with a Gaussian kernel G (x,y; t) of variance t, which can be the reference time" at chapter I, page 629)

The combination and Perona are combinable because all of them are related to the field of image processing.

It would have been obvious at the time the invention was made one of ordinary skill in the art to utilize the step of "I (x, y, t) [being] obtained by convolving the original image I_0 (x,y) with a Gaussian kernel G (x,y; t) of variance t", which can be the reference time (Perona; equation (1); chapter I, page 629) taught by Perona to the "EDF computation [] [representing] the changes in the location of edges" (Acar; ¶ 0015) when "[t]he EDF equation for the xy plane is $\nabla I_{z=k} \cdot v_{z=k} + \frac{\partial I_{z=k}}{\partial z} = 0$" (Acar; equation (1); ¶ 0016) and "$I_{z=k}(x, y)$ is the associate image" (Acar; ¶ 0017) of the combination.

The suggestion/motivation for doing so would have been to provide "[c]ausality [,] [which] [a]ny feature at a coarse level of resolution is required to possess (not a necessarily unique) "cause" at a finer level of resolution" (Perona;

chapter 1, page 629) and "no spurious detail should be generated when the resolution is diminished" (Perona; chapter 1, page 629), "[h]omogenity [and] [i]sotropy … for the sake of simplicity" (Perona; chapter 1, page 629).

Therefore, it would have been obvious to combine Townsend, De Murcia, Acar and Perona to obtain the invention specified in claim 24.

b. Regarding claim 32, claim 32 is analogous and corresponds to claim 24. See rejection of claim 24 for further explanation.

Conclusion

7. No claims are allowed.

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to JOHN LEE whose telephone number is (571)272-9554. The examiner can normally be reached on Monday - Friday (Alt.) 7:30 a.m. - 5:00 p.m..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Samir Ahmed can be reached on (571) 272-7413. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/JOHN W. LEE/
Primary Examiner, Art Unit 2624

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	96	"6490476"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:10
S2	5	09/685222	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:11
S3	6	"6527090"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:15
S4	41	"5124914"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:18
S5	5	"5333107"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:18

S6	1	07/788179	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:18
S7	9	"5408511"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:19
S8	8	"5475726"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:19
S9	4	"5406478"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:19
S10	1	08/249993	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:20
S11	9	"5444792"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:21

S12	6	"5814817"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:21
S13	0	08/667879	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:22
S14	6	"5889525"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:22
S15	5	"5933517"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:24
S16	5	"6103350"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:24
S17	2	"6920240"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:24

S18	4	"6888915"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:25
S19	2593	(bonnet-stephane.in. or bonnet.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:51
S20	96	(grangeat-pierre.in. or grangeat.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:51
S21	2686	S19 or S20	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:51
S22	283800	(mobile or techinque or measurement).clm.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:52
S23	54	S21 and S22	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:52

S25	2	"20040004405"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 00:08
S28	6918	382/128.ccls. or 345/420.ccls. or 600/427.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 00:09
S29	1	10/955037	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 00:19
S30	0	(displacement near3 fields) near3 PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:56
S31	8	(displacement near3 fields) near3 CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:56
S32	3	(displacement near3 fields) with PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57

S33	18	(displacement near3 fields) with CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S34	1	S32 and S33	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S35	8931	(displacement near3 fields)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S36	81	S35 and CT and PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S37	18	S36 and S28	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S38	1736832	(vector or displacement)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:06

S39	786	S38 near3 CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:07
S40	8098	S38 near3 PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:07
S41	75	S39 and S40	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:07
S42	3520	S38 with CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:07
S43	12182	S38 WITH PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:07
S44	195	S42 and S43	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:08

S45	1854	vector with CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:38
S46	11867	vector with PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:39
S47	181	S45 and S46	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:39
S48	504	gradient with CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:40
S49	425	gradient WITH PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:40
S50	11	S48 and S49	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:40

S51	4636	motion with CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:46
S52	1522	motion WITH PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:46
S53	164	S51 and S52	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:46
S54	54	S53 and vector	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:54
S55	79	S53 and (vector or displacement)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:54
S56	15542	displacement near3 (field or vector)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:36

S57	150	S56 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:36
S58	19316809	combin$3 or form$3 or fus$3	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:38
S59	13665	S56 and S58	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:39
S60	1486	S59 and medical	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:39
S61	144	S59 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:39
S62	994101	S58 near3 image	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:41

S63	3025	S62 and S56	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:42
S64	88	S63 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:42
S65	107	S56 with S62	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:54
S66	2	S65 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:54
S67	3	S65 and (x-ray and CT)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:56
S68	112890	goto.in.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:59

S69	59266	hitachi.asnm.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:59
S70	0	S68 and S69 and (displacment) and vector	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:00
S71	4	S68 and S69 and (displacement) and vector	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:00
S72	17	S68 and S69 and vector	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:00
S73	1	JP2006141534A	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:02
S74	25	S65 and "382".clas.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:03

S75	16464	gradient near3 time	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:24
S76	52	S75 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:24
S77	13	S76 and (x-ray and CT)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:24
S78	100	gradient near3 (reference near3 time)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:30
S79	0	S78 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:30
S80	4	S78 and (x-ray and CT)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:30

S81	0	S78 and "382".clas.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:31
S82	4551	total near3 derivative	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:33
S83	7	S82 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:33
S84	569	vector near3 (reference near3 time)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:35
S85	3	S84 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:35
S87	16464	gradient near3 time	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:37

S88	52	S87 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:37
S89	22	"5963665"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/08 21:22
S90	11431	(commissariat$5.asnm. or intellectual$7.asnm.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:52
S91	2593	(bonnet-stephane.in. or bonnet.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:52
S92	96	(grangeat-pierre.in. or grangeat.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:52
S93	2686	S91 or S92	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:52

S94	30	S90 and S93	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:52
S95	284977	(mobile or techinque or measurement).clm.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:53
S96	17	S94 and S95	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:53
S97	1	10/955037	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 11:22
S98	61088	sensor near3 camera	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:11
S99	3910	S98 and (CT or PET)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:11

S100	325	S98 and (CT and PET)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:11
S101	0	S100 and "382".ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:11
S102	239	S100 and patient	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:12
S103	325	S98 and (CT and PET)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:15
S104	180143	light near3 sensor	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:18
S105	10448	S104 with camera	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:19

S106	43	S105 and (CT and PET)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:19
S107	2	separat$3 near3 (sensor) near3 (PET)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 15:59
S108	19	separat$3 near3 (sensor) near3 (CT)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 15:59
S109	0	S107 and S108	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 15:59
S110	26	separat$3 with ((sensor) near3 (CT))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:00
S111	7	separat$3 with ((sensor) near3 (PET))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:01

S112	0	S110 and S111	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:01
S113	601999	image and sensors	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:01
S114	10464	CT near3 scanner	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:12
S115	564	PET near3 sensor	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:12
S116	988	CT near3 sensor	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:12
S117	9	S115 with S116	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:12

S118	1	10/955037	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:13
S119	12	S115 and S116	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:14
S120	3803	separat$3 near3 imag$3 near3 sensor	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:15
S121	118	S120 and CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:15
S122	26	S121 and "382".clas.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:15
S123	6	"5889525"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:53

S124	2	S123 and CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:56

7/5/2011 8:36:15 AM
C:\Documents and Settings\jlee15\My Documents\EAST\Workspaces\10955037 partial.wsp

UNITED STATES PATENT AND TRADEMARK OFFICE

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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/955,037	09/30/2004	Stephane Bonnet	27592-00987- US	4535

30678 7590 07/20/2011
CONNOLLY BOVE LODGE & HUTZ LLP
1875 EYE STREET, N.W.
SUITE 1100
WASHINGTON, DC 20006

EXAMINER	
LEE, JOHN W	
ART UNIT	PAPER NUMBER
2624	

MAIL DATE	DELIVERY MODE
07/20/2011	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Interview Summary	Application No.	Applicant(s)	
	10/955,037	BONNET ET AL.	
	Examiner	Art Unit	
	JOHN LEE	2624	

All participants (applicant, applicant's representative, PTO personnel):

(1) *JOHN LEE*. (3)_____.

(2) *Jeffferey Gluck*. (4)_____.

Date of Interview: *13 July 2011*.

Type: a)☒ Telephonic b)☐ Video Conference
c)☐ Personal [copy given to: 1)☐ applicant 2)☐ applicant's representative]

Exhibit shown or demonstration conducted: d)☐ Yes e)☐ No.
If Yes, brief description: _____.

Claim(s) discussed: _____.

Identification of prior art discussed: _____.

Agreement with respect to the claims f)☐ was reached. g)☒ was not reached. h)☐ N/A.

Substance of Interview including description of the general nature of what was agreed to if an agreement was reached, or any other comments: *The examiner acknowledges that there was a typo in the PTO-326 form, mailed on 7 July 2011, under the "Status" section. The check mark on 2a) is a typo, and 2b) should have been check marked because the office action was a non-final.*.

(A fuller description, if necessary, and a copy of the amendments which the examiner agreed would render the claims allowable, if available, must be attached. Also, where no copy of the amendments that would render the claims allowable is available, a summary thereof must be attached.)

THE FORMAL WRITTEN REPLY TO THE LAST OFFICE ACTION MUST INCLUDE THE SUBSTANCE OF THE INTERVIEW. (See MPEP Section 713.04). If a reply to the last Office action has already been filed, APPLICANT IS GIVEN A NON-EXTENDABLE PERIOD OF THE LONGER OF ONE MONTH OR THIRTY DAYS FROM THIS INTERVIEW DATE, OR THE MAILING DATE OF THIS INTERVIEW SUMMARY FORM, WHICHEVER IS LATER, TO FILE A STATEMENT OF THE SUBSTANCE OF THE INTERVIEW. See Summary of Record of Interview requirements on reverse side or on attached sheet.

/JOHN W. LEE/ Primary Examiner, Art Unit 2624	

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews
Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

———

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:
1) A brief description of the nature of any exhibit shown or any demonstration conducted,
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Stephane Bonnet et al.

Application No.: 10/955,037 | Confirmation No.: 4535

Filed: September 30, 2004 | Art Unit: 2624

For: METHOD OF RECONSTRUCTING AN IMAGE WITH DATA ACQUISITION ACCORDING TO SEVERAL IMAGERY MODES AND SYNCHRONISATION OF IMAGE SERIES | Examiner: J. W. Lee

RESPONSE TO NON-FINAL OFFICE ACTION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Applicants hereby respond to the Non-Final Office Action mailed July 20, 2011.

A listing of the claims, including amendments thereto, begins on page 2 of this paper.

Remarks begin on page 6 of this paper.

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
10/955,037	09/30/2004	

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)	SMALL ENTITY ☐ RATE ($)	SMALL ENTITY ☐ FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
FOR	NUMBER FILED	NUMBER EXTRA					
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT 09/27/2011

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 18	Minus	** 20	= 0	X $ =		OR	X $60=	0
Independent (37 CFR 1.16(h))	* 2	Minus	***4	= 0	X $ =		OR	X $250=	0
☐ Application Size Fee (37 CFR 1.16(s))									
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	0

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)	OR	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =		OR	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =		OR	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))									
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/TARA WITCHER/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Acknowledgement Receipt	
EFS ID:	11058935
Application Number:	10955037
International Application Number:	
Confirmation Number:	4535
Title of Invention:	Method of reconstructing an image with data acquisition according to several imagery modes and synchronisation of image series
First Named Inventor/Applicant Name:	Stephane Bonnet
Customer Number:	30678
Filer:	David M. Morse/Renee Conti
Filer Authorized By:	David M. Morse
Attorney Docket Number:	27592-00987- US
Receipt Date:	27-SEP-2011
Filing Date:	30-SEP-2004
Time Stamp:	14:56:38
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		Response_to_Nonfinal_Office_Action.pdf	571458 69bab115758ae6a67ac60d1532d8e83cffa46c65	yes	11

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	5
	Applicant Arguments/Remarks Made in an Amendment	6	11
Warnings:			
Information:			
	Total Files Size (in bytes):	571458	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

LISTING OF THE CLAIMS

Applicants hereby present the claims, their status in the application, and amendments thereto as indicated below. This listing of the claims replaces all prior versions and listings of the claims in this application.

1.-14. (Cancelled)

15. (Previously Presented) A method of forming an image of a mobile object, comprising:

obtaining a plurality of first images of the mobile object using a first imaging technique while obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system, the first sensor system being independent from the first imaging technique;

associating the plurality of first images with first movement states of the mobile object using the first measurements;

obtaining a plurality of second images of the mobile object using a second imaging technique while obtaining a plurality of second measurements corresponding to movements of the mobile object using a second sensor system, the second sensor system being independent from the second imaging technique;

associating the plurality of second images with second movement states of the mobile object using the first measurements; and

forming an image of the mobile object based on said plurality of first images, said associated plurality of first movement measurements, and said first movement states and on said plurality of second images, said associated plurality of second movement measurements, and said second movement states,

wherein the first imaging technique is different from the second imaging technique.

16. (Previously Presented) The method of Claim 15, further comprising:

time-synchronizing said first plurality of images and said second plurality of images to a common time scale based on the first and second movement states.

17. (Previously Presented) The method of Claim 15, further comprising:

forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images.

18. (Previously Presented) The method of Claim 17, further comprising:

spatially-synchronizing said first reconstructed images and said second reconstructed images.

19. (Previously Presented) The method of Claim 15, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique.

20. (Previously Presented) The method of Claim 15, further comprising:

spatially-synchronizing the plurality of first images and the plurality of second images using said plurality of first measurements and said plurality of second measurements.

21. (Previously Presented) The method of Claim 15, further comprising:

forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements.

22. (Previously Presented) The method of Claim 21, wherein said forming an image of the mobile object comprises combining said displacement fields.

23. (Previously Presented) The method of Claim 21, wherein said forming displacement fields comprises:

estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields.

24. (Previously Presented) The method of Claim 23, wherein at least one of said movement estimates is formed relative to a reference time.

25. (Previously Presented) The method of Claim 15, wherein the first sensor system is different from the second sensor system.

26. (Currently Amended) An apparatus to form an image of a mobile object, comprising:

means for obtaining a plurality of first images of the mobile object using a first imaging technique;

means for obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images, the means for obtaining the plurality of first measurements being independent from the first imaging technique;

means for associating the plurality of first images with first movement states of the mobile object using the first measurements;

means for obtaining a plurality of second images of the mobile object using a second imaging technique;

~~means for associating the plurality of second images with second movement states of the mobile object using the first measurements;~~

means for obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images, the means for obtaining the plurality of second measurements being independent from the second imaging technique; [[and]]

means for associating the plurality of second images with second movement states of the mobile object using the first measurements; and

means for forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of said second images, said associated plurality of second measurements, and said second movement states,

wherein the first imaging technique is different from the second imaging technique.

27. (Previously Presented) The apparatus of Claim 26, further comprising:

means for forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images.

28. (Previously Presented) The apparatus of Claim 26, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique.

29. (Previously Presented) The apparatus of Claim 26, further comprising:

means for forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements.

30. (Previously Presented) The apparatus of Claim 29, wherein said means for forming an image of the mobile object comprises means for combining said displacement fields.

31. (Previously Presented) The apparatus of Claim 29, wherein said means for forming displacement fields comprises:

means for estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields.

32. (Previously Presented) The apparatus of Claim 31, wherein at least one of said movement estimates is to be formed relative to a reference time.

33. (Canceled)

34. (Canceled)

REMARKS

Applicant thanks the Examiner for the careful consideration given to this application. Reconsideration is now respectfully requested in view of the following remarks.

Claims 15-32 are pending in this application. Claims 15 and 26 are independent claims. Claim 26 is presently amended. Claims 1-14, 33, and 34 were previously cancelled without prejudice or disclaimer. Reconsideration and allowance of the present application are respectfully requested.

Claim 26 was amended to rearrange the order of the sub-clauses in order to clarify the claimed subject matter.

CLAIM REJECTIONS UNDER 35 U.S.C. §112

Claims 15-32 were rejected under 35 U.S.C. § 112, first paragraph, on the assertion that they fail to comply with the written description requirement. The written description requirement of 35 U.S.C. § 112, first paragraph, requires only that the description in the specification "clearly allow[s] persons of ordinary skill in the art to recognize that he or she invented what is claimed." MPEP 2163.03 (*citing In re Gosteli*, 872 F.2d 1008, 1012, 10 USPQ2d 1614, 1618 (Fed. Cir. 1989).) In order to satisfy the test for meeting the written description requirement, an applicant "must convey with reasonable clarity to those skilled in the art that, as of the filing date sought, he or she was in possession of the invention." *Id.* Applicants' description is "***presumed adequate***, unless or until sufficient evidence or reasoning to the contrary has been presented by the examiner to rebut the presumption." MPEP 2163.04. (Emphasis added.) As part of rebutting this presumption, a *prima facie* case must be established that "a person skilled in the art at the time the application was filed would not have recognized that the inventor was in possession of the invention as claimed in view of the disclosure of the application as filed." MPEP 2163.04. Moreover, simple statements that the claim is not supported are insufficient in instances where applicant has pointed out where the limitation is supported. MPEP 2163.04(I). More detailed reasoning for the rejection is required in such instances. *Id.*

In the present application, Applicants previously amended claim 15 to recite "the first sensor system being independent from the first imaging technique" and "the second sensor system being independent from the second imaging technique." Claim 26 was amended to include analogous recitations. As support for these amendments, Applicants directed the Examiner to paragraph [0013] of the specification, which states

> Attenuation and emission measurements are made in steps Et1 and Et2 in FIG. 1. For each measurement category, measurement sets are taken at successive instants, which are usually not simultaneous for the two measurement categories. However, a time synchronisation of measurement sets is usually necessary, within the two series and between the two series after step Et3. One useful method for achieving this may be to ***measure a patient movement using an independent sensor*** such as a breathing sensor, a pressure sensor or an electrocardiogram. Each measurement set is then associated with a determined state of the patient during which a measurement of his movement was made." (Emphasis added.)

Since Applicants have pointed to a specific section of the specification where the limitation is supported, the Office Action has not established a *prima facie* case of failure to meet the written description requirement over claim 15 by the sweeping generalized statement that the claim amendments are "not supported by the specification." (Office Action mailed 7-20-2011, p. 3.) In view of the shortcomings in the Office Action, Applicants respectfully traverse the rejection under 35 U.S.C. § 112, first paragraph.

CLAIM REJECTIONS UNDER 35 U.S.C. §103

Claims 15-20 and 25-28 have been rejected under 35 U.S.C. §103 as being obvious over U.S. Patent Publication No. 2003/0004405 in the names of Townsend et al. (hereinafter "Townsend") in view of U.S. Patent No. 5,889,525 to De Murcia et al. (hereinafter "De Murcia").

Obviousness requires a determination that the claimed invention, *as a whole*, in view of the cited references, and without the benefit of hindsight, would have been obvious to one of ordinary skill in the art at the time it was made. MPEP 2142. Claim 15 recites, *inter alia*:

"obtaining a plurality of first images of the mobile object using a first imaging technique while obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system, *the first sensor system being independent from the first imaging technique*;

associating the plurality of first images with first movement states of the mobile object using the first measurements;

obtaining a plurality of second images of the mobile object using a second imaging technique while obtaining a plurality of second measurements corresponding to movements of the mobile object using a second sensor system, *the second sensor system being independent from the second imaging technique*;

associating the plurality of second images with second movement states of the mobile object using the first measurements; and

forming an image of the mobile object based on said plurality of first images, said associated plurality of first movement measurements, and said first movement states and on said plurality of second images, said associated plurality of second movement measurements, and said second movement states." (Emphasis added.)

The cited combination does not disclose the emphasized features.

The Office Action recognizes that Townsend does not teach or disclose these features. (Office Action mailed 7-20-2011, pp. 4-5.) The rejection therefore asserts that De Murcia discloses these features. However, De Murcia does not teach or disclose the first or second sensor systems, where each of the sensor systems is independent from the first and second imaging techniques, respectively. De Murcia discloses a system for taking measurements of a moving or deforming object, such as a heart, in Fig. 1, which includes a two-dimensional array (2) of sensors or transducers (3) that are mobile around a core (1) sliding on a rail (5). (De Murcia, Col. 3, ll. 25-36.) These sensors (3) are used to obtain a series of measurements of the object. (De Murcia, Col. 3, ll. 36-39.) The measurements correspond to different states of the object. (De Murcia, Col. 3, ll. 36-39.) The measurements are thereafter "successively entered in the calculations in

order to reconstruct on each occasion an estimate of the image." (De Murcia, Col. 4, ll. 9-13.) As is supported in Fig. 2 and the bulk of the disclosure, De Murcia teaches that the images are derived from the measurements following a series of calculations. (See De Murcia, Col. 3, l. 49 – Col. 5, l. 18.) Since De Murcia bases the entire image reconstruction on calculations following the measurements from the single disclosed measurement system, it does not disclose a "sensor system" that is independent from an "imaging technique." For this reason, Applicants respectfully request withdrawal of the rejection of claim 15 under 35 U.S.C. §103.

Claim 26 recites, *inter alia*:

> "means for obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images, *the means for obtaining the plurality of first measurements being independent from the first imaging technique*;
>
> *means for associating the plurality of first images with first movement states of the mobile object using the first measurements*;
>
> means for obtaining a plurality of second images of the mobile object using a second imaging technique;
>
> means for obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images, *the means for obtaining the plurality of second measurements being independent from the second imaging technique*;
>
> *means for associating the plurality of second images with second movement states of the mobile object using the first measurements.*" (Emphasis added.)

For the same reasons stated above with respect to claim 15, the cited combination does not disclose all the features of claim 26. For this reason, Applicants respectfully request withdrawal of the rejection of claim 26 under 35 U.S.C. §103.

Claims 16-20, 25, 27, and 28 were also rejected as obvious over Townsend in view of De Murcia, and each ultimately depends from one of claims 15 and 26. Where, as discussed above, the combination of Townsend and De Murcia does not render either of claims 15 or 26 obvious, this combination also does not render any of these

dependent claims obvious. For this reason, Applicants respectfully request withdrawal of the rejection of claims 16-20, 25, 27, and 28 under 35 U.S.C. §103.

Claims 21-23 and 29-31 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Townsend and further in view of U.S. Patent Publication No. 2004/0141638 in the names of Acar et al. (hereinafter "Acar"). Each of claims 21-23 and 29-31 ultimately depends from one of claims 15 and 26. As is discussed above, neither Townsend nor De Murcia disclose all the limitations of claims 15 and 26. Acar fails to teach or disclose those features that are not disclosed by Townsend and De Murcia. Therefore, the combination of Townsend, De Murcia, and Acar fails to teach or disclose all the limitations of claims 21-23 and 29-31. For this reason, Applicants respectfully request withdrawal of the rejection of claims 21-23 and 29-31 under 35 U.S.C. §103.

Claims 24 and 32 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Townsend in view of De Murcia, further in view of Acar et al., and in further view of "Scale-Space and Edge Detection Using Anisotropic Diffusion" by Perona et al. (hereinafter "Perona"). Each of claims 24 and 32 ultimately depends from one of claims 15 and 26. As is indicated above, the combination of Townsend, De Murcia, and Acar does not teach or disclose all the limitations of claims 15 and 26. Perona fails to teach or disclose those features that are not disclosed by Townsend, De Murcia, and Acar. Therefore, the combination of Townsend, De Murcia, Acar, and Perona fails to teach or disclose all the limitations of claims 24 and 32. For this reason, Applicants respectfully request withdrawal of rejection of claims 24 and 32 under 35 U.S.C. §103.

DISCLAIMER

Applicants may not have presented all possible arguments or have refuted the characterizations of either the claims or the prior art as found in the Office Action. However, the lack of such arguments or refutations is not intended to act as a waiver of such arguments or as concurrence with such characterizations.

CONCLUSION

In view of the above, consideration and allowance are respectfully solicited.

In the event the Examiner believes an interview might serve in any way to advance the prosecution of this application, the undersigned is available at the telephone number noted below.

Applicants believe no extensions or fees are due with this response. However, if an extension is needed or a fee is due, please consider this a request therefor and charge Deposit Account No. 22-0185, under Order No. 27592-00987-US, from which the undersigned is authorized to draw.

Dated: September 27, 2011

Respectfully submitted,

CONNOLLY BOVE LODGE & HUTZ LLP

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David M. Morse
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Attorneys for Applicants

Electronic Acknowledgement Receipt	
EFS ID:	11114117
Application Number:	10955037
International Application Number:	
Confirmation Number:	4535
Title of Invention:	Method of reconstructing an image with data acquisition according to several imagery modes and synchronisation of image series
First Named Inventor/Applicant Name:	Stephane Bonnet
Customer Number:	30678
Filer:	David M. Morse/Renee Conti
Filer Authorized By:	David M. Morse
Attorney Docket Number:	27592-00987- US
Receipt Date:	05-OCT-2011
Filing Date:	30-SEP-2004
Time Stamp:	11:57:19
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Miscellaneous Incoming Letter	Interview_Summary.pdf	66499 646db3e20cc616d7e50858219d476a1c8aae4428	no	3

Warnings:
Information:

Total Files Size (in bytes):	66499

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Stephane Bonnet et al.

Application No.: 10/955,037 | Confirmation No.: 4535

Filed: September 30, 2004 | Art Unit: 2624

For: METHOD OF RECONSTRUCTING AN IMAGE WITH DATA ACQUISITION ACCORDING TO SEVERAL IMAGERY MODES AND SYNCHRONISATION OF IMAGE SERIES | Examiner: J. W. Lee

INTERVIEW SUMMARY

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Applicants hereby submit this Interview Summary for an informal interview held with Examiner Lee on July 13, 2011.

Remarks, including the Interview Summary, begin on page 2 of this paper.

REMARKS

Applicant thanks the Examiner for taking the time to discuss this application with Applicants' representative on July 13, 2011. Applicants' representative contacted Examiner Lee to discuss the Office Action mailed on July 7, 2011, which was marked as a Final Office Action. However, that Office Action was responding to Applicants' Response filed on March 8, 2011 along with a Request for Continued Examination. Applicants' representative therefore believed that the Office Action should have been marked as a Non-Final Office Action and brought this to Examiner Lee's attention. Examiner Lee agreed.

The claims and the rejections thereto were not discussed.

CONCLUSION

In view of the above, consideration and allowance are respectfully solicited.

In the event the Examiner believes an additional interview might serve in any way to advance the prosecution of this application, the undersigned is available at the telephone number noted below.

Applicants believe no extensions or fees are due with this response. However, if an extension is needed or a fee is due, please consider this a request therefor and charge Deposit Account No. 22-0185, under Order No. 27592-00987-US, from which the undersigned is authorized to draw.

Dated: October 5, 2011

Respectfully submitted,

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David M. Morse
Registration No.: 50,505

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Attorneys for Applicants

Notice of References Cited	Application/Control No. 10/955,037	Applicant(s)/Patent Under Reexamination BONNET ET AL.	
	Examiner JOHN LEE	Art Unit 2624	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-4,694,156 A	09-1987	Swanberg, Melvin E.	250/214RC
*	B	US-5,621,532 A	04-1997	Ooki et al.	356/444
*	C	US-5,889,525 A	03-1999	De Murcia et al.	345/420
*	D	US-6,246,784 B1	06-2001	Summers et al.	382/128
*	E	US-2003/0004405 A1	01-2003	Townsend et al.	600/407
*	F	US-2003/0212320 A1	11-2003	Wilk et al.	600/407
*	G	US-2004/0105575 A1	06-2004	Ganz et al.	382/128
*	H	US-2004/0141638 A1	07-2004	Acar et al.	382/131
*	I	US-2004/0175832 A1	09-2004	Hui et al.	436/008
*	J	US-6,885,702 B1	04-2005	Goudezeune et al.	375/240.12
*	K	US-2007/0177778 A1	08-2007	Massaro, Peter	382/128
*	L	US-7,695,683 B2	04-2010	Quan et al.	422/504
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	10955037	BONNET ET AL.
	Examiner	Art Unit
	Lee, John W	2112

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/27/2006	09/07/2007	05/25/2008	11/07/2008	04/22/2009	11/20/2009	07/09/2010	01/12/2011	07/05/2011
	1	✓	-	-	-	-	-	-	-	-
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	30			✓	✓	✓	✓	✓	✓	✓
	31			✓	✓	✓	✓	✓	✓	✓
	32			✓	✓	✓	✓	✓	✓	✓
	33								✓	-
	34								✓	-

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	10955037	BONNET ET AL.
	Examiner	**Art Unit**
	Lee, John W	2112

SEARCHED			
Class	**Subclass**	**Date**	**Examiner**
382	128	12/26/2006	John W. Lee
345	420	12/26/2006	John W. Lee
382	128	11/06/2008	John W. Lee

SEARCH NOTES		
Search Notes	**Date**	**Examiner**
Inventor Search	12/26/2006	John W. Lee
East Search	12/26/2006	John W. Lee
IEEE (Non- Patent Literature Search)	12/26/2006	John W. Lee
EAST Search	11/06/2008	John W. Lee
EAST Search	4/22/2009	John W. Lee
EAST Search	11/20/2009	John W. Lee
Inventor Search (using EDAN)	7/9/2010	John W. Lee
Inventor Search (using EAST)	7/9/2010	John W. Lee
Assignee Search (using EAST)	7/9/2010	John W. Lee
EAST Search	7/1/2010	John W. Lee
Plus Search	7/6/2010	John W. Lee
NPL search (using google)	7/5/2010	John W. Lee
382/128, 345/420 and 600/427 (combined with keyword search)	7/1/2010	John W. Lee
EAST Search	1/12/2011	John W. Lee
EAST Search	7/4/2011	John W. Lee
EAST Search	11/6/2011	John W. Lee

INTERFERENCE SEARCH			
Class	**Subclass**	**Date**	**Examiner**

	/JOHN LEE/ Primary Examiner.Art Unit 2624

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	96	"6490476"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:10
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S3	6	"6527090"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:15
S4	41	"5124914"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:18
S5	5	"5333107"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:18
S6	1	07/788179	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:18
S7	9	"5408511"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:19
S8	8	"5475726"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:19
S9	4	"5406478"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:19
S10	1	08/249993	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:20
S11	9	"5444792"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:21
S12	6	"5814817"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:21
S13	0	08/667879	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:22
S14	6	"5889525"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:22
S15	5	"5933517"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:24
S16	5	"6103350"	US-PGPUB; USPAT; USOCR; EPO; JPO;	OR	ON	2010/06/30 16:24

			DERWENT; IBM_TDB			
S17	2	"6920240"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:24
S18	4	"6888915"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:25
S19	2593	(bonnet-stephane.in. or bonnet.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:51
S20	96	(grangeat-pierre.in. or grangeat.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:51
S21	2686	S19 or S20	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:51
S22	283800	(mobile or techinque or measurement).clm.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:52
S23	54	S21 and S22	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:52
S25	2	"20040004405"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 00:08
S28	6918	382/128.ccls. or 345/420.ccls. or 600/427.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 00:09
S29	1	10/955037	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 00:19
S30	0	(displacement near3 fields) near3 PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:56
S31	8	(displacement near3 fields) near3 CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:56
S32	3	(displacement near3 fields) with PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S33	18	(displacement near3 fields) with CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S34	1	S32 and S33	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S35	8931	(displacement near3 fields)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S36	81	S35 and CT and PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S37	18	S36 and S28	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S38	1736832	(vector or displacement)	US-PGPUB; USPAT; USOCR; EPO; JPO;	OR	ON	2010/07/01 03:06

			DERWENT; IBM_TDB			
S39	786	S38 near3 CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:07
S40	8098	S38 near3 PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:07
S41	75	S39 and S40	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:07
S42	3520	S38 with CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:07
S43	12182	S38 WITH PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:07
S44	195	S42 and S43	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:08
S45	1854	vector with CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:38
S46	11867	vector with PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:39
S47	181	S45 and S46	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:39
S48	504	gradient with CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:40
S49	425	gradient WITH PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:40
S50	11	S48 and S49	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:40
S51	4636	motion with CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:46
S52	1522	motion WITH PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:46
S53	164	S51 and S52	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:46
S54	54	S53 and vector	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:54
S55	79	S53 and (vector or displacement)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:54
S56	15542	displacement near3 (field or vector)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:36
S57	150	S56 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO;	OR	ON	2010/07/07 21:36

			DERWENT; IBM_TDB			
S58	19316809	combin$3 or form$3 or fus$3	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:38
S59	13665	S56 and S58	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:39
S60	1486	S59 and medical	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:39
S61	144	S59 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:39
S62	994101	S58 near3 image	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:41
S63	3025	S62 and S56	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:42
S64	88	S63 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:42
S65	107	S56 with S62	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:54
S66	2	S65 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:54
S67	3	S65 and (x-ray and CT)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:56
S68	112890	goto.in.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:59
S69	59266	hitachi.asnm.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:59
S70	0	S68 and S69 and (displacment) and vector	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:00
S71	4	S68 and S69 and (displacement) and vector	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:00
S72	17	S68 and S69 and vector	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:00
S73	1	JP2006141534A	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:02
S74	25	S65 and "382".clas.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:03
S75	16464	gradient near3 time	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:24
S76	52	S75 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO;	OR	ON	2010/07/07 22:24

			DERWENT; IBM_TDB			
S77	13	S76 and (x-ray and CT)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:24
S78	100	gradient near3 (reference near3 time)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:30
S79	0	S78 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:30
S80	4	S78 and (x-ray and CT)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:30
S81	0	S78 and "382".clas.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:31
S82	4551	total near3 derivative	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:33
S83	7	S82 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:33
S84	569	vector near3 (reference near3 time)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:35
S85	3	S84 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:35
S87	16464	gradient near3 time	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:37
S88	52	S87 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:37
S89	22	"5963665"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/08 21:22
S90	11431	(commissariat$5.asnm. or intellectual$7.asnm.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:52
S91	2593	(bonnet-stephane.in. or bonnet.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:52
S92	96	(grangeat-pierre.in. or grangeat.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:52
S93	2686	S91 or S92	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:52
S94	30	S90 and S93	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:52
S95	284977	(mobile or techinque or measurement).clm.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:53
S96	17	S94 and S95	US-PGPUB; USPAT; USOCR; EPO; JPO;	OR	ON	2010/07/09 00:53

			DERWENT; IBM_TDB			
S97	1	10/955037	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 11:22
S98	61088	sensor near3 camera	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:11
S99	3910	S98 and (CT or PET)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:11
S100	325	S98 and (CT and PET)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:11
S101	0	S100 and "382".ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:11
S102	239	S100 and patient	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:12
S103	325	S98 and (CT and PET)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:15
S104	180143	light near3 sensor	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:18
S105	10448	S104 with camera	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:19
S106	43	S105 and (CT and PET)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:19
S107	2	separat$3 near3 (sensor) near3 (PET)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 15:59
S108	19	separat$3 near3 (sensor) near3 (CT)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 15:59
S109	0	S107 and S108	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 15:59
S110	26	separat$3 with ((sensor) near3 (CT))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:00
S111	7	separat$3 with ((sensor) near3 (PET))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:01
S112	0	S110 and S111	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:01
S113	601999	image and sensors	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:01
S114	10464	CT near3 scanner	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:12
S115	564	PET near3 sensor	US-PGPUB; USPAT; USOCR; EPO; JPO;	OR	ON	2011/07/04 16:12

			DERWENT; IBM_TDB			
S116	988	CT near3 sensor	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:12
S117	9	S115 with S116	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:12
S118	1	10/955037	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:13
S119	12	S115 and S116	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:14
S120	3803	separat$3 near3 imag$3 near3 sensor	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:15
S121	118	S120 and CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:15
S122	26	S121 and "382".clas.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:15
S123	6	"5889525"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:53
S124	2	S123 and CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:56

11/6/2011 11:50:58 AM
C:\Users\jlee15\Documents\EAST\Workspaces\10955037 partial.wsp

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/955,037	09/30/2004	Stephane Bonnet	27592-00987- US	4535

30678 7590 11/09/2011

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EXAMINER	
LEE, JOHN W	

ART UNIT	PAPER NUMBER
2624	

MAIL DATE	DELIVERY MODE
11/09/2011	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/955,037	BONNET ET AL.	
	Examiner	Art Unit	
	JOHN LEE	2624	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *27 September 2011*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

5)☒ Claim(s) *1-34* is/are pending in the application.

5a) Of the above claim(s) *1-15,33 and 34* is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *15-32* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

12)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment/Arguments

1. Applicant's amendment and arguments filed on 27 September 2011 have been fully considered.

2. Summary of applicant's remarks

1) Status of the claims:

- Claims 15-32 remain pending
- Claim 26 is amended
- Claims 1-14 and 33-34 are canceled

2) Ground of rejections to be reviewed based on applicant's remarks:

- Rejection of claims 15-32 under 35 U.S.C. §112, first paragraph
- Rejection of claims 15-32 under 35 U.S.C. 103(a)

3. Response to Applicant's remarks

1) Rejection of claims 15-32 under 35 U.S.C. § 112, first paragraph:

Applicant's arguments are persuasive. The rejection will be withdrawn.

2) Rejection of claims 15-32 under 35 U.S.C. § 103(a):

Applicant's arguments are not persuasive. The applicant discloses that "using a first sensor system, the first sensor system being independent from the first imaging technique;

associating the plurality of first images with first movement states of the mobile object using the first measurements;

using a second sensor system, the second sensor system being independent from the second imaging technique;

associating the plurality of second images with second movement states of the mobile object using the first measurements" are not disclosed by the combination of the prior art cited by the examiner.

The applicant also discloses that "using a first sensor system, the first sensor system being independent from the first imaging technique;

associating the plurality of first images with first movement states of the mobile object using the first measurements;

using a second sensor system, the second sensor system being independent from the second imaging technique;

associating the plurality of second images with second movement states of the mobile object using the first measurements" is supported by ¶0013 of the original specification.

Let's look at De Murcia (US 5,889,525), which the examiner cited as the secondary reference. De Murcia teaches "an approximate image of the object in each state (f) is reconstituted on the basis of associated measurements and the movements of said object from a reference state to each of the states are evaluated" (abstract; Fig. 2; equation (2); col. 4, line 1-col. 5, line 18), which is similar with the disclosure of ¶0013

of the original specification and claim 15 of the limitations which the applicant argues that the combination of the prior art does not disclose.

For the above reason, the claim rejection cannot be withdrawn, and the rejection will be maintained.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 15-20 and 25-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Townsend et al. (US 2003/0004405 A1) in view of De Murcia et al. (US 5,889,525).

a. Regarding claim 15, Townsend discloses a method of forming an image (Fig.3; “image fusion” at ¶ 0080) of a mobile object (Fig. 2b; “patient” at ¶¶ 0070 and 0073), comprising:

obtaining a plurality of first images (“CT images” at ¶ 0075) of the mobile object (Fig. 2b; “patient” at ¶¶ 0070 and 0073) using a first imaging technique (“X-ray CT” at ¶¶ 0070 and 0073);

obtaining a plurality of second images (“PET images” at ¶0075) of the mobile object (Fig. 2b; “patient” at ¶¶ 0070 and 0073) using a second imaging technique (“PET” at ¶¶ 0070 and 0073); and

forming an image (Fig.3; “image fusion” at ¶ 0080) of the mobile object (Fig. 2b; “patient” at ¶¶ 0070 and 0073) based on said plurality of first images (“CT images” at ¶ 0075) and said associated plurality of first movement (Fig. 11A; “internal organ movement” at abstract and ¶ 0101) measurements (Fig. 2b-12; “X-ray CT detectors” at ¶ 0073) and on said plurality of said second images (“PET images” at ¶0075) and said associated plurality of second movement (Fig. 11B; “internal organ movement” at abstract and ¶ 0101) measurements (Fig. 2b-14; “PET tomograph detectors” at ¶ 0073),

wherein the first imaging technique (“X-ray CT” at ¶¶ 0070 and 0073) is different from the second imaging technique (“PET” at ¶¶ 0070 and 0073; “The first imaging technique is a X-ray CT that is different with the second imaging technique, which is a PET.”) .

However, Townsend does not disclose obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system, the first sensor system being independent from the first imaging technique;

associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements;

obtaining a plurality of second movement measurements corresponding to movements of the mobile object using a second sensor system, the second sensor system being independent from the second imaging;

associating the plurality of second images with second movement states of the mobile object, the second movement states being determined by the second measurements;

Instead of Townsend, De Murcia discloses obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system, the first sensor system being independent from the first imaging technique ("an approximate image of the object in each state (f) is reconstituted on the basis of associated measurements and the movements of said object from a reference state to each of the states are evaluated" at abstract; Fig. 2; equation (2); col. 4, line 1-col. 5, line 18);

associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements ("an approximate image of the object in each state (f) is reconstituted on the basis of associated measurements and the movements of said object from a reference state to each of the states are evaluated" at abstract; Fig. 2; equation (2); col. 4, line 1-col. 5, line 18);

obtaining a plurality of second movement measurements corresponding to movements of the mobile object using a second sensor system, the second sensor system being independent from the second imaging ("an approximate image of the object in each state (f) is reconstituted on the basis of associated measurements and the movements of said object from a reference state to each of the states are evaluated" at abstract; Fig. 2; equation (2); col. 4, line 1-col. 5, line 18);

associating the plurality of second images with second movement states of the mobile object, the second movement states being determined by the second measurements ("an approximate image of the object in each state (f) is reconstituted on

the basis of associated measurements and the movements of said object from a reference state to each of the states are evaluated" at abstract; Fig. 2; equation (2); col. 4, line 1-col. 5, line 18);

Townsend and De Murcia are combinable because both are related to the field of medical image processing.

At the time the invention was made, it would have been obvious to one of the ordinary skill in the art to utilize the process of De Murcia to Townsend's invention.

The suggestion/motivation for doing so would have been to obtain "satisfactory imaging results without making the apparatus more complicated" (De Murcia; col. 2, lines 44-46).

Therefore, it would have been obvious to combine Townsend and De Murcia to obtain the invention specified in claim 15.

b. Regarding claim 16, Townsend further discloses further comprising: time-synchronizing said first plurality of images and said second plurality of images to a common time scale, the common time scale being determined by a comparison between the first and second movement states said first movement measurements and said second movement measurements ("The invention shows that synchronization, which "the CT scan is acquired before the PET scan, following a sixty (60) minute uptake period F-FDG activity has been injected into the patient"" at ¶ 0075).

c. Regarding claim 17, Townsend further discloses further comprising:

forming first reconstructed images corresponding to said plurality of first images ("[t]he CT images [being] reconstructed" at ¶ 0075) and second reconstructed images

corresponding to said plurality of second images (“the PET images [being] then reconstructed” ¶ 0075).

d. Regarding claim 18, Townsend further discloses further comprising:

spatially-synchronizing (“image fusion” at ¶ 0080) said first reconstructed images and said second reconstructed images (”fused PET and CT images" at ¶ 0080).

e. Regarding claim 19, Townsend further discloses wherein said first imaging technique being a radiation attenuation technique (“X-ray CT” at ¶¶ 0070 and 0073) and said second imaging technique being a radiation emission technique (“PET” at ¶¶ 0070 and 0073).

f. Regarding claim 20, Townsend discloses further comprising:

further comprising: spatially-synchronizing the plurality of first images and the plurality of second images using information based on said plurality of first measurements and said plurality of second movement measurements (“positional correspondence between the two image sets" at ¶ 0080)

g. Regarding claim 25, De Murcia discloses wherein the first sensor system is different from the second sensor system (Fig. 2; equation (2); col. 4, line 1-col. 5, line 18).

h. Regarding claim 26, claim 26 is a system claim analogous and corresponds to claim 15. See rejection of claim 15 for further explanation.

i. Regarding claim 27, claim 27 is a system claim analogous and corresponds to claim 17. See rejection of claim 17 for further explanation.

j. Regarding claim 28, claim 28 is a system claim analogous and corresponds to claim 19. See rejection of claim 19 for further explanation.

5. Claims 21-23 and 29-31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Townsend et al. (US 2003/0004405 A1) in view of Acar et al. (US 2004/0141638 A1).

a Regarding claim 21, The combination of Townsend and De Murcia disclose all the previous claim limitations including said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements (De Murcia;Fig. 2; equation (2); col. 4, line 1-col. 5, line 18).

However, the combination does not disclose forming displacement fields.

Instead of the combination, Acar, the same field of medical image processing discloses forming displacement fields (equation (1); FIG. 1; "It is shown that the EDF, "$v_{z=k}$ (x,y)" is computed from z=k to z=k+1" at ¶¶ 0013-0014 and 0015-0017).

The combination and Acar are combinable because both are related to the field of medical image processing.

It would have been obvious at the tie the invention was made to one of the ordinary skill in the art to utilize the step of computing "EDF, $v_{z=k}$ (x,y) from z=k to z=k+1" (Acar; equation (1); FIG.1; ¶¶ 0013-0014 and 0015-0017) taught by Acar to the combination.

The suggestion/motivation for doing so would have been to "characteriz[e] the topology of the vector field for detection, identification or recognition tasks of a structure of interest" (Acar; ¶ 0006) "with a high specificity without sacrificing the sensitivity of detection" (Acar; ¶ 0006).

Therefore, it would have been obvious to combine Townsend, De Murcia and Acar to obtain the invention specified in claim 21.

b. Regarding claim 22, the combination of Townsend De Murcia and Acar, as applied in claim 21, discloses all the previous claim limitations including said forming an image (Townsend; Fig.3; "image fusion" at ¶ 0080) of the mobile object (Townsend; Fig. 2b; "patient" at ¶¶ 0070 and 0073).

Moreover, Acar discloses combining said displacement fields (FIG. 1; "$v_{z=k}$ (x,y) for all k are summed ,,, to get a composite EDF" at ¶ 0017).

Townsend, De Murcia and Acar are combinable because both are related to the field of medical image processing.

It would have been obvious at the tie the invention was made to one of the ordinary skill in the art to utilize the step of computing "$v_{z=k}$ (x,y) for all k being summed ,,, to get a composite EDF" (Acar; FIG.1; ¶ 0017) taught by Acar to the combination.

The suggestion/motivation for doing so would have been to "determine parameters … [which] are used to classify the structure of interest" (Acar; ¶ 0007) and "refine the results of high sensitivity, low specificity pre-detection by increasing specificity without sacrificing sensitivity" (Acar; ¶ 0013).

Therefore, it would have been obvious to combine Townsend, De Murcia and Acar to obtain the invention specified in claim 22.

c. Regarding claim 23, the combination of Townsend, De Murcia and Acar, as applied in claim 21, discloses wherein said forming displacement fields (Acar; equation (1); FIG. 1; "It is shown that the EDF, "$v_{z=k}$ (x,y)" is computed from z=k to z=k+1" at ¶¶ 0013-0014 and 0015-0017) comprises:

estimating movement (Acar; equation (1); "EDF computation to represent the changes in the location of edges" at ¶ 0015) of the mobile object (Acar; "images such as tissue/air boundaries" at ¶ 0015) based, respectively, on said plurality of first images (Townsend; "CT images" at ¶ 0075), said plurality of second images (Townsend; "PET images" at ¶0075), said plurality of first measurements, and said plurality of second measurements (De Murcia; Fig. 2; equation (2); col. 4, line 1-col. 5, line 18).

d. Regarding claim 29, claim 29 is analogous and corresponds to claim 21. See rejection of claim 21 for further explanation.

e. Regarding claim 30, claim 30 is analogous and corresponds to claim 22. See rejection of claim 22 for further explanation.

f. Regarding claim 31, claim 31 is analogous and corresponds to claim 23. See rejection of claim 23 for further explanation.

6. Claims 24 and 32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Townsend et al. (US 2003/0004405 A1) in view of De Murcia et al. (US 5,889,525),

and further in view of Acar et al. (US 2004/0141638 A1) and Perona et al. ("Scale-Space and Edge Detection Using Anisotropic Diffusion").

a. Regarding claim 24, the combination of Townsend De Murcia and Acar, as applied in claim 23, discloses all the previous claim limitations including wherein at least one of said movement estimates (Acar; equation (1); "EDF computation to represent the changes in the location of edges" at ¶ 0015).

However, the combination does not disclose the estimates being formed relative to a reference time.

Instead of the combination, Perona, the same field of endeavor of image processing, discloses the estimates being formed relative to a reference time (equation (1); "It is shown that I (x, y, t) is obtained by convolving the original image I_0 (x,y) with a Gaussian kernel G (x,y; t) of variance t, which can be the reference time" at chapter I, page 629)

The combination and Perona are combinable because all of them are related to the field of image processing.

It would have been obvious at the time the invention was made one of ordinary skill in the art to utilize the step of "I (x, y, t) [being] obtained by convolving the original image I_0 (x,y) with a Gaussian kernel G (x,y; t) of variance t", which can be the reference time (Perona; equation (1); chapter I, page 629) taught by Perona to the "EDF computation [] [representing] the changes in the location of edges" (Acar; ¶ 0015) when "[t]he EDF equation for the xy plane is $\nabla I_{z=k} \cdot v_{z=k} + \frac{\partial I_{z=k}}{\partial z} = 0$" (Acar; equation (1); ¶ 0016) and "$I_{z=k}(x, y)$ is the associate image" (Acar; ¶ 0017) of the combination.

The suggestion/motivation for doing so would have been to provide "[c]ausality [,] [which] [a]ny feature at a coarse level of resolution is required to possess (not a necessarily unique) "cause" at a finer level of resolution" (Perona; chapter 1, page 629) and "no spurious detail should be generated when the resolution is diminished" (Perona; chapter 1, page 629), "[h]omogenity [and] [i]sotropy … for the sake of simplicity" (Perona; chapter 1, page 629).

Therefore, it would have been obvious to combine Townsend, De Murcia, Acar and Perona to obtain the invention specified in claim 24.

b. Regarding claim 32, claim 32 is analogous and corresponds to claim 24. See rejection of claim 24 for further explanation.

Conclusion

7. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to JOHN LEE whose telephone number is (571)272-9554. The examiner can normally be reached on Monday - Friday (Alt.) 7:30 a.m. - 5:00 p.m..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Samir Ahmed can be reached on (571) 272-7413. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/JOHN W. LEE/
Primary Examiner, Art Unit 2624

PTO/SB/31 (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

NOTICE OF APPEAL FROM THE EXAMINER TO THE BOARD OF PATENT APPEALS AND INTERFERENCES	Docket Number (Optional) 27592-00987-US

In re Application of	Stephane Bonnet et al.
Application Number	10/955,037-Conf. #4535
Filed	September 30, 2004
For	Method of reconstructing an image with data acquisition according to several imagery modes and synchronisation of image series
Art Unit	2624
Examiner	J. W. Lee

Applicant hereby **appeals** to the Board of Patent Appeals and Interferences from the last decision of the examiner.

The fee for this Notice of Appeal is (37 CFR 41.20(b)(1)) $ 620.00

[ ] Applicant claims small entity status. See 37 CFR 1.27. Therefore, the fee shown above is reduced by half, and the resulting fee is: $ _____

[ ] A check in the amount of the fee is enclosed.

[x] Payment by credit card. Form PTO-2038 is attached.

[ ] The Director has already been authorized to charge fees in this application to a Deposit Account.

[x] The Director is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. 22-0185 .

[ ] A petition for an extension of time under 37 CFR 1.136(a) (PTO/SB/22) is enclosed.

WARNING: INFORMATION ON THIS FORM MAY BECOME PUBLIC. CREDIT CARD INFORMATION SHOULD NOT BE INCLUDED ON THIS FORM. PROVIDE CREDIT CARD INFORMATION AND AUTHORIZATION ON PTO-2038.

I am the

[ ] applicant /inventor.

[ ] assignee of record of the entire interest. See 37 CFR 3.71. Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)

[x] attorney or agent of record.
Registration number 50,505

[ ] attorney or agent acting under 37 CFR 1.34.
Registration number if acting under 37 CFR 1.34. _____

/DMMorse/
Signature

David M. Morse
Typed or printed name

(302) 658-9141
Telephone number

February 7, 2012
Date

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

[x] *Total of 1 forms are submitted.

Electronic Patent Application Fee Transmittal	
Application Number:	10955037
Filing Date:	30-Sep-2004
Title of Invention:	Method of reconstructing an image with data acquisition according to several imagery modes and synchronisation of image series
First Named Inventor/Applicant Name:	Stephane Bonnet
Filer:	Jefferson Allen Cheatham/Shirley Brooks
Attorney Docket Number:	27592-00987- US
Filed as Large Entity	

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Notice of appeal	1401	1	620	620
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
		Total in USD ($)		**620**

Electronic Acknowledgement Receipt	
EFS ID:	12017145
Application Number:	10955037
International Application Number:	
Confirmation Number:	4535
Title of Invention:	Method of reconstructing an image with data acquisition according to several imagery modes and synchronisation of image series
First Named Inventor/Applicant Name:	Stephane Bonnet
Customer Number:	30678
Filer:	Jefferson Allen Cheatham/Shirley Brooks
Filer Authorized By:	Jefferson Allen Cheatham
Attorney Docket Number:	27592-00987- US
Receipt Date:	07-FEB-2012
Filing Date:	30-SEP-2004
Time Stamp:	14:15:23
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$620
RAM confirmation Number	541
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Notice of Appeal Filed	27592-00987US_NoticeofAppeal.pdf	53740 a07cec43507b4b67c327a2f0c2f6f50585306bcf	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30294 d34774c7831fc194c1239083bad6e37af86ba695	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	84034	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Electronic Patent Application Fee Transmittal				
Application Number:	10955037			
Filing Date:	30-Sep-2004			
Title of Invention:	Method of reconstructing an image with data acquisition according to several imagery modes and synchronisation of image series			
First Named Inventor/Applicant Name:	Stephane Bonnet			
Filer:	David M. Morse/Renee Tamboles			
Attorney Docket Number:	27592-00987- US			
Filed as Large Entity				
Utility under 35 USC 111(a) Filing Fees				
Description	**Fee Code**	**Quantity**	**Amount**	**Sub-Total in USD($)**
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Filing a brief in support of an appeal	1402	1	620	620
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
		Total in USD ($)		**620**

Electronic Acknowledgement Receipt	
EFS ID:	12467435
Application Number:	10955037
International Application Number:	
Confirmation Number:	4535
Title of Invention:	Method of reconstructing an image with data acquisition according to several imagery modes and synchronisation of image series
First Named Inventor/Applicant Name:	Stephane Bonnet
Customer Number:	30678
Filer:	David M. Morse/Renee Tamboles
Filer Authorized By:	David M. Morse
Attorney Docket Number:	27592-00987- US
Receipt Date:	04-APR-2012
Filing Date:	30-SEP-2004
Time Stamp:	14:39:18
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$620
RAM confirmation Number	1070
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Appeal Brief Filed	Appeal_Brief.pdf	112980 efcda7b93d16294011c403972d9fba9d392e5de4	no	18
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30307 94e15d874d43f84f246a64d40ac0fe19c7950dde	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	143287		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:	Group Art Unit: 2624
Stéphane Bonnet et al.	Confirmation No.: 4535
Serial No.: 10/955,037	Examiner: John W. Lee
Filed: September 30, 2004	
For: METHOD OF RECONSTRUCTING AN IMAGE WITH DATA ACQUISITION ACCORDING TO SEVERAL IMAGERY MODES AND SYNCHRONISATION OF IMAGE SERIES	

APPEAL BRIEF

MS Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

The Notice of Appeal in this case was filed on February 7, 2012.

All appropriate Appeal Brief fees are being filed concurrently herewith as shown on the Fee Sheet, including any applicable extension of time fees. Appellants believe that no additional fees are due with this filing. However, if an additional extension is needed or a fee is due, please consider this a request therefor and charge Deposit Account No. 03-2775, under Order No. 27592-00982-US, from which the undersigned is authorized to draw.

This brief contains items under the following headings as required by 37 C.F.R. § 41.37(c):

I. Real Party In Interest
II Related Appeals and Interferences
III. Summary of Claimed Subject Matter
IV. Argument
Appendix A Claims

I. REAL PARTY IN INTEREST

The real party in interest for this Appeal is Commissariat a L'Energie Atomique, the assignee of record of the entire right, title and interest in the subject patent application.

II. RELATED APPEALS AND INTERFERENCES

Appellants are aware of no related proceedings currently pending before the Board.

III. SUMMARY OF CLAIMED SUBJECT MATTER

The claimed subject matter is directed toward a method and an apparatus for forming an image of a mobile object. In each of the method and the apparatus, two different imaging techniques and two independent sensor systems are used. The two different imaging techniques are each used to obtain a plurality of images of the mobile object. Each sensor system is independent from and associated with one of the respective imaging techniques, and each is used to obtain a plurality of measurements corresponding to movements of the mobile object. Using the respective movement measurements, the plurality of images from each imaging technique are associated with movement states of the mobile object. An image of the mobile object may then be formed using the images obtained from each imaging technique, the respective movement measurements, and the respective movement states.

A. Claim 15 is directed toward a method of forming an image of a mobile object. Support for claim 15 in the specification is as follows:

obtaining a plurality of first images of the mobile object using a first imaging technique while obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system, the first sensor system being independent from the first imaging technique:

Fig. 1, refs. Et1, Et11; Page 3, lines 24-25; Page 4, lines 24-28; Page 5, lines 16-17, 20-26; Page 6, lines 6-13 ; and Page 18, lines 1-5.

associating the plurality of first images with first movement states of the mobile object using the first measurements:

Fig. 1, ref. Et3; Fig. 2; Page 5, line 26 – page 6, line 5; Page 6, lines 13-16.

obtaining a plurality of second images of the mobile object using a second imaging technique while obtaining a plurality of second measurements corresponding to movements of the mobile object using a second sensor system, the second sensor system being independent from the second imaging technique:

Fig. 1, refs. Et2, Et12; Page 3, lines 24-25; Page 4, lines 24-28; Page 5, lines 16-17, 20-26; Page 6, lines 6-13 ; and Page 18, lines 1-5.

associating the plurality of second images with second movement states of the mobile object using the first measurements:

Fig. 1, ref. Et3; Fig. 2; Page 5, line 26 – page 6, line 5; Page 6, lines 13-16.

forming an image of the mobile object based on said plurality of first images, said associated plurality of first movement measurements, and said first movement states and on said plurality of second images, said associated plurality of second movement measurements, and said second movement states:

Fig. 1, refs. Et6, Et7, Et8, Et9, Et10, Et17, Et18; Page 7, lines 3-17 ; Page 8, line 6 – page 11, line 2 ; Page 11, line 26 – page 17, line 28.

wherein the first imaging technique is different from the second imaging technique:

Fig. 1, refs. Et1, Et2; Page 3, lines 24-25; Page 4, lines 24-28; Page 5, lines 16-17; and Page 18, lines 1-5.

B. Claim 16 depends from claim 15, and is directed toward time-synchronizing the first and second plurality of images of claim 15. Support for claim 16 in the specification is as follows:

time-synchronizing said first plurality of images and said second plurality of images to a common time scale based on the first and second movement states:

Fig. 1, ref. Et3; Fig. 2; Page 5, line 16 – page 6, line 5; Page 6, line 25 – page 7, line 2; Page 11, lines 3-25.

C. Claim 26 is directed toward an apparatus for forming an image of a mobile object. Support for claim 26 in the specification is as follows:

means for obtaining a plurality of first images of the mobile object using a first imaging technique:

Fig. 1, ref. Et1; Page 3, lines 24-25; Page 4, lines 24-28; Page 5, lines 16-17; and Page 18, lines 1-5.

means for obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images, the means for obtaining the plurality of first measurements being independent from the first imaging technique:

Fig. 1, ref. Et11; Page 5, lines 20-26; and Page 6, lines 6-13.

means for associating the plurality of first images with first movement states of the mobile object using the first measurements:

Fig. 1, ref. Et3; Fig. 2; Page 5, line 26 – page 6, line 5; Page 6, lines 13-16.

means for obtaining a plurality of second images of the mobile object using a second imaging technique:

Fig. 1, ref. Et2; Page 3, lines 24-25; Page 4, lines 24-28; Page 5, lines 16-17; and Page 18, lines 1-5.

means for obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images, the means for obtaining the plurality of second measurements being independent from the second imaging technique:

Fig. 1, ref. Et12; Page 5, lines 20-26; and Page 6, lines 6-13.

means for associating the plurality of second images with second movement states of the mobile object using the first measurements:

Fig. 1, ref. Et3; Fig. 2; Page 5, line 26 – page 6, line 5; Page 6, lines 13-16.

means for forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of said second images, said associated plurality of second measurements, and said second movement states:

Fig. 1, refs. Et6, Et7, Et8, Et9, Et10, Et17, Et18; Page 7, lines 3-17 ; Page 8, line 6 – page 11, line 2 ; Page 11, line 26 – page 17, line 28.

wherein the first imaging technique is different from the second imaging technique:

Fig. 1, refs. Et1, Et2; Page 3, lines 24-25; Page 4, lines 24-28; Page 5, lines 16-17; and Page 18, lines 1-5.

IV. ARGUMENT

A. Summary of the Argument

The combination of U.S. Patent Publication No. 2003/0004405 in the names of Townsend et al. (hereinafter "Townsend") in view of U.S. Patent No. 5,889,525 to De Murcia et al. (hereinafter "De Murcia") do not support the stated reasons in the Office Action for establishing obviousness over any of the pending claims in the present application. As a threshold matter, the combination of Townsend and De Murcia do not teach or disclose all the features of independent claims 15 and 26. In addition, the inclusion of a movement measurement system to Townsend, as suggested in the Office Action, would add unnecessary complexity to a system which already discloses a way to compensate for imaging a mobile object. Further, neither Townsend nor De Murcia discloses the time synchronization feature recited in dependent claim 16. For these reasons, the obviousness rejection is improper and should be reversed.

B. Rejection under 35 U.S.C. § 103(a) over Townsend in view of De Murcia

Obviousness requires a determination that the claimed invention, *as a whole*, in view of the cited references, and without the benefit of hindsight, would have been obvious to one of ordinary skill in the art at the time it was made. MPEP 2142. In making this determination, the Office Action must set forth a clear articulation of the reasons why one of ordinary skill in the art would combine the teachings of the cited references. *Id*. In the present application, the obviousness rejection set forth in the Office Action has two critical flaws: 1) the cited combination of Townsend and De Murcia does not disclose all the features of the independent claims; and 2) the suggested combination adds complexity to the imaging techniques of Townsend in order to make "movement measurements," even where Townsend expressly discloses that the imaging techniques themselves compensate for imaging a mobile object. Either one of these critical flaws is sufficient, in itself, as a basis for reversing the obviousness rejection.

1. Independent Claim 15

Claim 15 is independent, and each of claims 16-25 ultimately depend from claim 15. Although Appellants are not presently arguing separate patentability for any of claims 17-25, Appellants reserve the right to raise such arguments following resolution of this Appeal. Therefore, for purposes of this Appeal, the rejections of claims 17-25 stand or fall with the rejections of claim 15. Claim 15 recites, *inter alia*:

> "obtaining a plurality of first images of the mobile object using a first imaging technique *while obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system, the first sensor system being independent from the first imaging technique*;
>
> associating the plurality of first images with first movement states of the mobile object using the first measurements;
>
> obtaining a plurality of second images of the mobile object using a second imaging technique *while obtaining a plurality of second measurements corresponding to movements of the mobile object using a second sensor system, the second sensor system being independent from the second imaging technique*;
>
> associating the plurality of second images with second movement states of the mobile object using the first measurements; and
>
> forming an image of the mobile object based on said plurality of first images, said associated plurality of first movement measurements, and said first movement states and on said plurality of second images, said associated plurality of second movement measurements, and said second movement states." (Emphasis added.)

The cited combination does not disclose the emphasized features, and including these features into the system of Townsend, as suggested by the Office Action, would add unnecessary complexity to the system of Townsend.

a. Neither Townsend nor De Murcia disclose sensor systems that are independent from the imaging technique

Townsend discloses two imaging techniques, but it does not disclose the first and second sensor systems that are independent from the first and second imaging techniques, respectively. This shortcoming of Townsend is recognized in the Office Action. (Office Action, pp. 5-6, "Townsend does not disclose obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system, the first sensor system being independent from the first imaging technique … obtaining a plurality of second movement measurements corresponding to movements of the mobile object using a second sensor system, the second sensor system being independent from the second imaging [technique]."))[1]

The Office Action asserts that De Murcia discloses a sensor system that is independent from an imaging technique. But this is not what De Murcia discloses. De Murcia discloses a system for taking measurements of a moving or deforming object, such as a heart, which includes a two-dimensional array (2) of sensors or transducers (3) that are mobile around a core (1) sliding on a rail (5). (De Murcia, Col. 3, ll. 25-36; Fig. 1.) *Notably, De Murcia does not disclose any imaging or measurement devices*

[1] The Office Action is inconsistent with respect to the first and second movement measurements. The Office Action at one point asserts that Townsend discloses "forming an image of the mobile object based on said plurality of first images and *said associated plurality of first movement measurements* and on said plurality of second images and *said associated plurality of second movement measurements*." (Townsend, page 5, lines 1-7, *emphasis added*.) Yet on that same page the Office Action states that Townsend *does not disclose* obtaining the first or second movement measurements. (See Townsend, page 5, lines 12-14 and 17-19.) Thus, according to the reasoning of the Office Action, Townsend does not disclose obtaining the first or second movement measurements, but it does disclose using the first and second movement measurements to form the image of the mobile object. While this issue is not determinative of the Appeal, it is the most egregious example of the flawed reasoning used to support the obviousness rejections.

other than the sensors. These sensors (3) are used to obtain a series of measurements of the object, which correspond to different states of the object. (De Murcia, Col. 3, ll. 36-39.) The measurements are thereafter "successively entered in the calculations in order to reconstruct on each occasion an estimate of the image." (De Murcia, Col. 4, ll. 9-13.) As is supported in Fig. 2 and the bulk of the disclosure of De Murcia, the resulting images are derived from the measurements obtained from the sensors following a series of calculations. (See De Murcia, Col. 3, l. 49 – Col. 5, l. 18.) Since De Murcia bases the entire image reconstruction on calculations from the measurements obtained using the only disclosed measurement system, i.e., the sensors, De Murcia merely discloses a "sensor system," or alternatively an "imaging technique," but not a "sensor system" that is independent from an "imaging technique." Therefore, the combination of Townsend in view of De Murcia does not disclose all the limitations of claim 15.

b. The suggested combination of the teachings of Townsend and De Murcia adds unnecessary complexity to the system of Townsend

Townsend discloses obtaining two sets of images, one from a CT scanning technique and the other from a PET imaging technique, and combining the two sets of images through what is described as "image fusion." (*See* Townsend, [0080].) Townsend also expressly addresses how images of a mobile object are obtained and processed during the image fusion process. Specifically, Townsend indicates that the disclosed imaging techniques overcome any shortcomings associated with imaging a mobile object. Townsend describes the "image fusion" process as follows:

> "The tomograph acquires functional and anatomical images which are accurately co-registered, without the use of external markers or internal landmarks. A secondary objective is to use the CT data to improve the correction of the PET data for attenuation and for contamination from scattered photons. By using the CT image in this manner, low-noise

attenuation correction factors for PET are generated, and by integrating the anatomical information from the CT into scatter correction methods, an accurate scatter correction is obtained." (Townsend, [0036].)

For the coregistration process, Townsend discloses that "in regions such as the thorax, respiration and cardiac motion may result in some intrinsic misalignment [in the coregistered images]." (Townsend, [0109].) For CT scanning, Townsend expressly discloses that the solution to imaging a mobile object is found through performing a spiral CT scan. (*Id.*) According to Townsend, by performing a spiral CT scan, "motion artifacts are limited almost exclusively to the lingual and the lower lung segments in close contact with the left ventricle. *The shorter scan times possible with spiral CT have essentially eliminated artifacts from cardiovascular motion*." (*Id.*, *Emphasis added.*) Townsend also expressly addresses imaging a mobile object with a PET scan, indicating that "[t]he ungated PET image, on the other hand, represents an average over the scan duration of typically 5-10 minutes." (*Id.*) According to Townsend, during the PET scan, "the patient breathes normally and the resulting PET image is an integration over the respiratory and cardiac cycles." (*Id.*) Since the PET image results from an integration over time, any movement of the mobile object will be compensated for by the integration process.

Townsend therefore expressly discloses solutions for both CT and PET scanning that compensate for imaging a mobile object, rendering any further compensation superfluous for these imaging techniques. Thus, the introduction of a movement measurement system, as proposed by the Office Action through the combination of Townsend with De Murcia, would add unnecessary complexity to solve a problem for which Townsend has already provided an acceptable solution. Moreover, the Office Action has not presented any rationale or motivation for introducing the added complexity to the system of Townsend. For these reasons, Appellants request reversal of the rejection of claim 15 under 35 U.S.C. §103.

2. Dependent Claim 16

Claim 16 depends from claim 15, and Appellants present the following further reasons showing why the combination of Townsend in view of De Murcia does not establish a *prima facie* case of obviousness over claim 16.

Claim 16 recites "time-synchronizing said first plurality of images and said second plurality of images to a common time scale, the common time scale being determined by a comparison between the first and second movement states." The Office Action indicates that Townsend discloses time-synchronization when "the CT scan is acquired before the PET scan, following a sixty (60) minute uptake period F-FDG activity has been injected into the patient." (Office Action, p. 7, *quoting* ¶ 75 of Townsend.) However, even if this process described in Townsend is, *arguendo*, a form of time-synchronization by having the second imaging technique performed at a specified time following performance of the first imaging technique, such linear time sequencing does not include time-synchronization to a common time scale that is "determined by a comparison between the first and second movement states." In fact, the movement states of the mobile object would have no bearing on the type of time-synchronization posed in the Office Action, and the images obtained by the different techniques still would have no common time scale. For these additional reasons, the Office Action has not established a *prima facie* case of obviousness over dependent claim 16, and Appellants therefore request reversal of the obviousness rejection of claim 16 under 35 U.S.C. § 103.

3. Independent Claim 26

Claim 26 is independent, and each of claims 27-32 ultimately depend from claim 26. Although Appellants are not presently arguing separate patentability for any of claims 27-32, Appellants reserve the right to raise such arguments following resolution

of this Appeal. Therefore, for purposes of this Appeal, the rejections of claims 27-32 stand or fall with the rejections of claim 26. Claim 26 recites, *inter alia*:

> "*means for obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images, the means for obtaining the plurality of first measurements being independent from the first imaging technique*;
>
> means for associating the plurality of first images with first movement states of the mobile object using the first measurements;
>
> means for obtaining a plurality of second images of the mobile object using a second imaging technique;
>
> *means for obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images, the means for obtaining the plurality of second measurements being independent from the second imaging technique*;
>
> means for associating the plurality of second images with second movement states of the mobile object using the first measurements." (Emphasis added.)

For the same reasons stated above with respect to claim 15, the cited combination does not disclose the emphasized features of claim 26. Appellants therefore request reversal of the rejection of claim 26 under 35 U.S.C. §103.

C. DISCLAIMER

Appellants may not have presented all possible arguments or have refuted the characterizations of either the claims or the prior art as found in the Office Action. However, the lack of such arguments or refutations is not intended to act as a waiver of such arguments or as concurrence with such characterizations.

D. Conclusion

For the foregoing reasons, Appellants submit that each of claims 15-32 are not obvious over the combination of Townsend in view of De Murcia. Appellants therefore respectfully request reversal of the rejections in this matter.

Dated: April 4, 2012

Respectfully submitted,

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APPENDIX A

Claims Involved in the Appeal of Application Serial No. 10/955,037

1.-14. (Cancelled)

15. (Previously Presented) A method of forming an image of a mobile object, comprising:

obtaining a plurality of first images of the mobile object using a first imaging technique while obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system, the first sensor system being independent from the first imaging technique;

associating the plurality of first images with first movement states of the mobile object using the first measurements;

obtaining a plurality of second images of the mobile object using a second imaging technique while obtaining a plurality of second measurements corresponding to movements of the mobile object using a second sensor system, the second sensor system being independent from the second imaging technique;

associating the plurality of second images with second movement states of the mobile object using the first measurements; and

forming an image of the mobile object based on said plurality of first images, said associated plurality of first movement measurements, and said first movement states and on said plurality of second images, said associated plurality of second movement measurements, and said second movement states,

wherein the first imaging technique is different from the second imaging technique.

16. (Previously Presented) The method of Claim 15, further comprising:

time-synchronizing said first plurality of images and said second plurality of images to a common time scale based on the first and second movement states.

17. (Previously Presented) The method of Claim 15, further comprising:

forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images.

18. (Previously Presented) The method of Claim 17, further comprising:

spatially-synchronizing said first reconstructed images and said second reconstructed images.

19. (Previously Presented) The method of Claim 15, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique.

20. (Previously Presented) The method of Claim 15, further comprising:

spatially-synchronizing the plurality of first images and the plurality of second images using said plurality of first measurements and said plurality of second measurements.

21. (Previously Presented) The method of Claim 15, further comprising:

forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements.

22. (Previously Presented) The method of Claim 21, wherein said forming an image of the mobile object comprises combining said displacement fields.

23. (Previously Presented) The method of Claim 21, wherein said forming displacement fields comprises:

estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields.

24. (Previously Presented) The method of Claim 23, wherein at least one of said movement estimates is formed relative to a reference time.

25. (Previously Presented) The method of Claim 15, wherein the first sensor system is different from the second sensor system.

26. (Previously Presented) An apparatus to form an image of a mobile object, comprising:

means for obtaining a plurality of first images of the mobile object using a first imaging technique;

means for obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images, the means for obtaining the plurality of first measurements being independent from the first imaging technique;

means for associating the plurality of first images with first movement states of the mobile object using the first measurements;

means for obtaining a plurality of second images of the mobile object using a second imaging technique;

means for obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images, the means for obtaining the plurality of second measurements being independent from the second imaging technique;

means for associating the plurality of second images with second movement states of the mobile object using the first measurements; and

means for forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of said second images, said associated plurality of second measurements, and said second movement states,

wherein the first imaging technique is different from the second imaging technique.

27. (Previously Presented) The apparatus of Claim 26, further comprising:

means for forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images.

28. (Previously Presented) The apparatus of Claim 26, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique.

29. (Previously Presented) The apparatus of Claim 26, further comprising:

means for forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements.

30. (Previously Presented) The apparatus of Claim 29, wherein said means for forming an image of the mobile object comprises means for combining said displacement fields.

31. (Previously Presented) The apparatus of Claim 29, wherein said means for forming displacement fields comprises:

means for estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first

measurements, and said plurality of second measurements, in order to form said displacement fields.

32. (Previously Presented) The apparatus of Claim 31, wherein at least one of said movement estimates is to be formed relative to a reference time.

33. (Canceled)

34. (Canceled)

Notice of References Cited	Application/Control No. 10/955,037	Applicant(s)/Patent Under Reexamination BONNET ET AL.	
	Examiner JOHN LEE	Art Unit 2624	Page 1 of 1

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*	B	US-5,621,532 A	04-1997	Ooki et al.	356/444
*	C	US-5,889,525 A	03-1999	De Murcia et al.	345/420
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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
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	Q					
	R					
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NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S140	0	((form$3 or fus$3 and composit$3) and image and ((mobile or move) near3 object) and (first with technique) and (second with technique) and plurality and movement and (first with sensor) and (second with sensor) and independent and asscociat$3 and (first with state) and (second with state)).clm.	US-PGPUB; UPAD	OR	OFF	2012/05/01 20:33

Issue Classification	**Application/Control No.**	**Applicant(s)/Patent Under Reexamination**
	10955037	BONNET ET AL.
	Examiner	**Art Unit**
	JOHN LEE	2624

ORIGINAL		**INTERNATIONAL CLASSIFICATION**									
CLASS	**SUBCLASS**	**CLAIMED**					**NON-CLAIMED**				
382	128	G	0	6	K	9 / 00 (2006.01.01)					

CROSS REFERENCE(S)					
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**				
382	131				
345	420				
378	4	21			
250	363.04				
600	427				

☐ **Claims renumbered in the same order as presented by applicant** ☐ **CPA** ☐ **T.D.** ☐ **R.1.47**

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
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1	15	17	31												
2	16	18	32												

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	18	
/JOHN LEE/ Primary Examiner.Art Unit 2624	05/02/2012	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	Fig. 2

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	10955037	BONNET ET AL.
	Examiner	Art Unit
	JOHN LEE	2624

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

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CLAIM		DATE								
Final	Original	12/27/2006	09/07/2007	05/25/2008	11/07/2008	04/22/2009	11/20/2009	07/09/2010	01/12/2011	05/02/2012
	1	✓	-	-	-	-	-	-	-	-
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10	24			✓	✓	✓	✓	✓	✓	=
11	25			✓	✓	✓	✓	✓	✓	=
12	26			✓	✓	✓	✓	✓	✓	=
13	27			✓	✓	✓	✓	✓	✓	=
14	28			✓	✓	✓	✓	✓	✓	=
15	29			✓	✓	✓	✓	✓	✓	=
16	30			✓	✓	✓	✓	✓	✓	=
17	31			✓	✓	✓	✓	✓	✓	=
18	32			✓	✓	✓	✓	✓	✓	=
	33								✓	-
	34								✓	-

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	10955037	BONNET ET AL.
	Examiner	Art Unit
	Lee, John W	2112

SEARCHED			
Class	Subclass	Date	Examiner
382	128	12/26/2006	John W. Lee
345	420	12/26/2006	John W. Lee
382	128	11/06/2008	John W. Lee

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor Search	12/26/2006	John W. Lee
East Search	12/26/2006	John W. Lee
IEEE (Non- Patent Literature Search)	12/26/2006	John W. Lee
EAST Search	11/06/2008	John W. Lee
EAST Search	4/22/2009	John W. Lee
EAST Search	11/20/2009	John W. Lee
Inventor Search (using EDAN)	7/9/2010	John W. Lee
Inventor Search (using EAST)	7/9/2010	John W. Lee
Assignee Search (using EAST)	7/9/2010	John W. Lee
EAST Search	7/1/2010	John W. Lee
Plus Search	7/6/2010	John W. Lee
NPL search (using google)	7/5/2010	John W. Lee
382/128, 345/420 and 600/427 (combined with keyword search)	7/1/2010	John W. Lee
EAST Search	1/12/2011	John W. Lee
EAST Search	7/4/2011	John W. Lee
EAST Search	11/6/2011	John W. Lee
345/420.ccls. (combine with keyword)	5/1/2012	John W. Lee
378/4.ccls. or 378/21-27.ccls. (combined with keyword)	5/1/2012	John W. Lee
250/363.04.ccls. (combined with keyword)	5/1/2012	John W. Lee
600/427.ccls. (combined with keyword)	5/1/2012	John W. Lee
382/128-134.ccls. (combined with keyword)	5/1/2012	John W. Lee
EAST Search	5/1/2012	John W. Lee

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner

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See interference printout	USPGPUB and UPAD text Search	5/1/2012	John W. Lee

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EXAMINER
LEE, JOHN W

ART UNIT	PAPER NUMBER
2624	

DATE MAILED: 05/07/2012

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/955,037	09/30/2004	Stephane Bonnet	27592-00987- US	4535

TITLE OF INVENTION: METHOD OF RECONSTRUCTING AN IMAGE WITH DATA ACQUISITION ACCORDING TO SEVERAL IMAGERY MODES AND SYNCHRONISATION OF IMAGE SERIES

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1740	$300	$0	$2040	08/07/2012

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check box 5a on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and 1/2 the ISSUE FEE shown above.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PTOL-85 (Rev. 02/11)

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

30678 7590 05/07/2012
CONNOLLY BOVE LODGE & HUTZ LLP
1875 EYE STREET, N.W.
SUITE 1100
WASHINGTON, DC 20006

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/955,037	09/30/2004	Stephane Bonnet	27592-00987- US	4535

TITLE OF INVENTION: METHOD OF RECONSTRUCTING AN IMAGE WITH DATA ACQUISITION ACCORDING TO SEVERAL IMAGERY MODES AND SYNCHRONISATION OF IMAGE SERIES

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1740	$300	$0	$2040	08/07/2012

EXAMINER	ART UNIT	CLASS-SUBCLASS
LEE, JOHN W	2624	382-128000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:

❑ Issue Fee

❑ Publication Fee (No small entity discount permitted)

❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**

❑ A check is enclosed.

❑ Payment by credit card. Form PTO-2038 is attached.

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)

❑ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

❑ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/955,037	09/30/2004	Stephane Bonnet	27592-00987- US	4535

30678 7590 05/07/2012

CONNOLLY BOVE LODGE & HUTZ LLP
1875 EYE STREET, N.W.
SUITE 1100
WASHINGTON, DC 20006

EXAMINER	
LEE, JOHN W	
ART UNIT	**PAPER NUMBER**
2624	

DATE MAILED: 05/07/2012

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 224 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 224 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

PTOL-85 (Rev. 02/11)

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 10/955,037	Applicant(s) BONNET ET AL.	
	Examiner JOHN LEE	Art Unit 2624	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *4 April 2012*.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *15-32 (reclaim as claims 1-18)*.
4. ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☒ All b) ☐ Some* c) ☐ None of the:
      1. ☒ Certified copies of the priority documents have been received.
      2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
      3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☐ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

/JOHN W. LEE/
Primary Examiner, Art Unit 2624

REASONS FOR ALLOWANCE

1. The following is an examiner's statement of reasons for allowance: After reviewing the claims and the appeal brief filed on 4 April 2012, it came to the conclusion that the claim limitations- "obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system, the first sensor system being independent from the first imaging technique;

associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements;

obtaining a plurality of second movement measurements corresponding to movements of the mobile object using a second sensor system, the second sensor system being independent from the second imaging;

associating the plurality of second images with second movement states of the mobile object, the second movement states being determined by the second measurements", are distinct comparing with prior arts cited and searched by the examiner.

2. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

3. Any inquiry concerning this communication or earlier communications from the examiner should be directed to JOHN LEE whose telephone number is (571)272-9554. The examiner can normally be reached on Monday - Friday (Alt.) 7:30 a.m. - 5:00 p.m..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Samir Ahmed can be reached on (571) 272-7413. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/JOHN W. LEE/
Primary Examiner, Art Unit 2624

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	96	"6490476"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:10
S2	5	09/685222	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:11
S3	6	"6527090"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:15
S4	41	"5124914"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:18
S5	5	"5333107"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:18
S6	1	07/788179	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:18
S7	9	"5408511"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:19
S8	8	"5475726"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:19
S9	4	"5406478"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:19
S10	1	08/249993	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:20
S11	9	"5444792"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:21
S12	6	"5814817"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:21
S13	0	08/667879	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:22
S14	6	"5889525"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:22
S15	5	"5933517"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:24
S16	5	"6103350"	US-PGPUB; USPAT; USOCR; EPO; JPO;	OR	ON	2010/06/30 16:24

			DERWENT; IBM_TDB			
S17	2	"6920240"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:24
S18	4	"6888915"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:25
S19	2593	(bonnet-stephane.in. or bonnet.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:51
S20	96	(grangeat-pierre.in. or grangeat.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:51
S21	2686	S19 or S20	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:51
S22	283800	(mobile or techinque or measurement).clm.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:52
S23	54	S21 and S22	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/06/30 16:52
S25	2	"20040004405"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 00:08
S28	6918	382/128.ccls. or 345/420.ccls. or 600/427.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 00:09
S29	1	10/955037	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 00:19
S30	0	(displacement near3 fields) near3 PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:56
S31	8	(displacement near3 fields) near3 CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:56
S32	3	(displacement near3 fields) with PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S33	18	(displacement near3 fields) with CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S34	1	S32 and S33	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S35	8931	(displacement near3 fields)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S36	81	S35 and CT and PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S37	18	S36 and S28	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 02:57
S38	1736832	(vector or displacement)	US-PGPUB; USPAT; USOCR; EPO; JPO;	OR	ON	2010/07/01 03:06

			DERWENT; IBM_TDB			
S39	786	S38 near3 CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:07
S40	8098	S38 near3 PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:07
S41	75	S39 and S40	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:07
S42	3520	S38 with CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:07
S43	12182	S38 WITH PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:07
S44	195	S42 and S43	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:08
S45	1854	vector with CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:38
S46	11867	vector with PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:39
S47	181	S45 and S46	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:39
S48	504	gradient with CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:40
S49	425	gradient WITH PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:40
S50	11	S48 and S49	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:40
S51	4636	motion with CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:46
S52	1522	motion WITH PET	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:46
S53	164	S51 and S52	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:46
S54	54	S53 and vector	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:54
S55	79	S53 and (vector or displacement)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/01 03:54
S56	15542	displacement near3 (field or vector)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:36
S57	150	S56 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO;	OR	ON	2010/07/07 21:36

			DERWENT; IBM_TDB			
S58	19316809	combin$3 or form$3 or fus$3	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:38
S59	13665	S56 and S58	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:39
S60	1486	S59 and medical	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:39
S61	144	S59 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:39
S62	994101	S58 near3 image	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:41
S63	3025	S62 and S56	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:42
S64	88	S63 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:42
S65	107	S56 with S62	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:54
S66	2	S65 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:54
S67	3	S65 and (x-ray and CT)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:56
S68	112890	goto.in.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:59
S69	59266	hitachi.asnm.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 21:59
S70	0	S68 and S69 and (displacment) and vector	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:00
S71	4	S68 and S69 and (displacement) and vector	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:00
S72	17	S68 and S69 and vector	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:00
S73	1	JP2006141534A	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:02
S74	25	S65 and "382".clas.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:03
S75	16464	gradient near3 time	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:24
S76	52	S75 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO;	OR	ON	2010/07/07 22:24

			DERWENT; IBM_TDB			
S77	13	S76 and (x-ray and CT)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:24
S78	100	gradient near3 (reference near3 time)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:30
S79	0	S78 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:30
S80	4	S78 and (x-ray and CT)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:30
S81	0	S78 and "382".clas.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:31
S82	4551	total near3 derivative	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:33
S83	7	S82 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:33
S84	569	vector near3 (reference near3 time)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:35
S85	3	S84 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:35
S87	16464	gradient near3 time	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:37
S88	52	S87 and 382/128.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/07 22:37
S89	22	"5963665"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/08 21:22
S90	11431	(commissariat$5.asnm. or intellectual$7.asnm.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:52
S91	2593	(bonnet-stephane.in. or bonnet.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:52
S92	96	(grangeat-pierre.in. or grangeat.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:52
S93	2686	S91 or S92	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:52
S94	30	S90 and S93	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:52
S95	284977	(mobile or techinque or measurement).clm.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/07/09 00:53
S96	17	S94 and S95	US-PGPUB; USPAT; USOCR; EPO; JPO;	OR	ON	2010/07/09 00:53

			DERWENT; IBM_TDB			
S97	1	10/955037	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 11:22
S98	61088	sensor near3 camera	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:11
S99	3910	S98 and (CT or PET)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:11
S100	325	S98 and (CT and PET)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:11
S101	0	S100 and "382".ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:11
S102	239	S100 and patient	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:12
S103	325	S98 and (CT and PET)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:15
S104	180143	light near3 sensor	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:18
S105	10448	S104 with camera	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:19
S106	43	S105 and (CT and PET)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/05/11 13:19
S107	2	separat$3 near3 (sensor) near3 (PET)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 15:59
S108	19	separat$3 near3 (sensor) near3 (CT)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 15:59
S109	0	S107 and S108	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 15:59
S110	26	separat$3 with ((sensor) near3 (CT))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:00
S111	7	separat$3 with ((sensor) near3 (PET))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:01
S112	0	S110 and S111	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:01
S113	601999	image and sensors	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:01
S114	10464	CT near3 scanner	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:12
S115	564	PET near3 sensor	US-PGPUB; USPAT; USOCR; EPO; JPO;	OR	ON	2011/07/04 16:12

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S116	988	CT near3 sensor	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:12
S117	9	S115 with S116	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:12
S118	1	10/955037	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:13
S119	12	S115 and S116	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:14
S120	3803	separat$3 near3 imag$3 near3 sensor	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:15
S121	118	S120 and CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:15
S122	26	S121 and "382".clas.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:15
S123	6	"5889525"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:53
S124	2	S123 and CT	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/07/04 16:56
S126	2031	345/420.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/05/01 20:26
S127	4392	378/4.ccls. or 378/21-27.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/05/01 20:26
S128	781	250/363.04.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/05/01 20:26
S129	885	600/427.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/05/01 20:26
S130	12596	382/128-134.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/05/01 20:26
S131	19750	S126 or S127 or S128 or S129 or S130	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/05/01 20:26
S132	582346	two with imag$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/05/01 20:27
S133	12795	S131 and S132	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/05/01 20:27
S134	7003	CT near4 PET	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/05/01 20:27
S135	1157	S133 and S134	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2012/05/01 20:27

			DERWENT; IBM_TDB			
S136	387	S135 and independent	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2012/05/01 20:27

5/1/2012 8:34:55 PM
C:\Users\jlee15\Documents\EAST\Workspaces\10955037 partial.wsp

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
10/955,037	09/30/2004	2624	1120	27592-00987- US	8	1

CONFIRMATION NO. 4535

CORRECTED FILING RECEIPT

30678
CONNOLLY BOVE LODGE & HUTZ LLP
1875 EYE STREET, N.W.
SUITE 1100
WASHINGTON, DC 20006

OC000000054795453

Date Mailed: 06/12/2012

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Stephane Bonnet, Seyssinet-Pariset, FRANCE;
Pierre Grangeat, Saint Ismier, FRANCE;

Power of Attorney: The patent practitioners associated with Customer Number 30678

Domestic Priority data as claimed by applicant

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)
FRANCE 03 50631 10/01/2003

If Required, Foreign Filing License Granted: 08/19/2005

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 10/955,037**

Projected Publication Date: Not Applicable

Non-Publication Request: No

Early Publication Request: No

Title

METHOD OF RECONSTRUCTING AN IMAGE ACQUIRED USING SEVERAL IMAGERY MODES

Preliminary Class

382

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/955,037	09/30/2004	Stephane Bonnet	27592-00987- US	4535

30678 7590 06/13/2012
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WASHINGTON, DC 20006

EXAMINER	
LEE, JOHN W	
ART UNIT	**PAPER NUMBER**
2624	

MAIL DATE	DELIVERY MODE
06/13/2012	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

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Application No. : 10955037
Applicant : Bonnet
Filing Date : 09/30/2004
Date Mailed : 06/13/2012

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Notice of Allowance Mailed

This application has been accorded an Allowance Date and is being prepared for issuance. The application, however, is incomplete for the reasons below.

Applicant is given 2 month(s) from the mail date of this Notice, or the time remaining from the Notice of Allowance and Fee(s) Due, whichever is longer, within which to respond.

The informalities requiring correction are indicated in the attachment(s). If the informality pertains to the abstract, specification (including claims) or drawings, the informality must be corrected with an amendment in compliance with 37 CFR 1.121 (or, if the application is a reissue application, 37 CFR 1.173). Such an amendment may be filed after payment of the issue fee if limited to correction of informalities noted herein. See Waiver of 37 CFR 1.312 for Documents Required by the Office of Patent Publication, 1280 Off. Gaz. Patent Office 918 (March 23, 2004). In addition, if the informality is not corrected until after payment of the issue fee, for purposes of 35 U.S.C. 154(b)(1)(iv), "all outstanding requirements" will be considered to have been satisfied when the informality has been corrected. A failure to respond within the above-identified time period will result in the application being ABANDONED. **This period for reply is NOT extendable under 37 CFR 1.136(a).**

See attachment(s).

A copy of this notice MUST be returned with the reply. Please address response to "Mail Stop Issue Fee,Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450".

/Joanna Black/
Publication Branch
Office of Data Management
(571) 272-4200

Application No. 10955037

IDENTIFICATION OF SPECIFICATION/DRAWING INCONSISTENCIES

☐ On Page of the specification there is a brief description of FIG. , but the drawings filed do not include a drawing with that designation. Applicant must respond either by supplying the omitted drawing or by amending the specification to remove all references to that drawing.

☐ The drawings filed include FIG. , but the specification's brief description of the drawings does not describe a drawing with that designation. Applicant must respond either by amending the specification to add a brief description of that drawing or by correcting the drawings to remove the drawing in question.

☒ Drawings are present in the application and are referred to in the detailed description of the invention, but the specification does not contain a brief description of the drawings as required by 37 CFR 1.74 and 37 CFR 1.77(b)(8).

☐ Page of the specification refers to FIG. , but no drawing with that designation is described in the brief description of the drawings and no drawing with that designation is present in the application. Applicant must respond either by amending the specification to remove all references to that drawing, or by supplying that drawing and amending the specification to add a brief description of it.

☐ OTHER:

☐ COMMENTS:

Electronic Acknowledgement Receipt	
EFS ID:	13059141
Application Number:	10955037
International Application Number:	
Confirmation Number:	4535
Title of Invention:	METHOD OF RECONSTRUCTING AN IMAGE ACQUIRED USING SEVERAL IMAGERY MODES
First Named Inventor/Applicant Name:	Stephane Bonnet
Customer Number:	30678
Filer:	Burton A. Amernick/Valerie Williams
Filer Authorized By:	Burton A. Amernick
Attorney Docket Number:	27592-00987- US
Receipt Date:	20-JUN-2012
Filing Date:	30-SEP-2004
Time Stamp:	12:38:47
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Miscellaneous Incoming Letter	Resp_NTF_Corr_Appln_papers.pdf	561494 9f87343431815bea14034ff908084ae47043727c	no	4
Warnings:					
Information:					

Total Files Size (in bytes):	561494

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Docket No.: 27592-00987-US
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Stephane Bonnet et al.

Application No.: 10/955,037 | Confirmation No.: 4535

Filed: September 30, 2004 | Art Unit: 2624

For: METHOD OF RECONSTRUCTING AN IMAGE WITH DATA ACQUISITION ACCORDING TO SEVERAL IMAGERY MODES AND SYNCHRONISATION OF IMAGE SERIES | Examiner: J. W. Lee

RESPONSE TO NOTICE TO FILE CORRECTED APPLICATION PAPERS

MS Issue Fee
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir or Madam:

This paper is in response to the Notice to File Corrected Application Papers ("the Notice") issued by the U.S. Patent & Trademark Office dated June 13, 2012. The Notice alleges that the specification lacks a brief description of the drawings. However, attention is directed to the top of page 5 of the application as originally filed (page 5, lines 1-3), which, Applicants respectfully submit, is a brief description of the drawings. Therefore, Applicants respectfully request that the requirement that a brief description of the drawings be added to the specification be withdrawn.

4888077

Applicant believes no fee is due with this response. However, if a fee is due, please charge our Deposit Account No. 22-0185, under Order No. 27592-00987-US, from which the undersigned is authorized to draw.

Dated: June 20, 2012

Respectfully submitted,

Electronic signature: /Jeffrey W. Gluck/
Jeffrey W. Gluck
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Attorney for Applicant

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Application No. : 10955037
Applicant : Bonnet
Filing Date : 09/30/2004
Date Mailed : 06/13/2012

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Notice of Allowance Mailed

This application has been accorded an Allowance Date and is being prepared for issuance. The application, however, is incomplete for the reasons below.

Applicant is given 2 month(s) from the mail date of this Notice, or the time remaining from the Notice of Allowance and Fee(s) Due, whichever is longer, within which to respond.

The informalities requiring correction are indicated in the attachment(s). If the informality pertains to the abstract, specification (including claims) or drawings, the informality must be corrected with an amendment in compliance with 37 CFR 1.121 (or, if the application is a reissue application, 37 CFR 1.173). Such an amendment may be filed after payment of the issue fee if limited to correction of informalities noted herein. See Waiver of 37 CFR 1.312 for Documents Required by the Office of Patent Publication, 1280 Off. Gaz. Patent Office 918 (March 23, 2004). In addition, if the informality is not corrected until after payment of the issue fee, for purposes of 35 U.S.C. 154(b)(1)(iv), "all outstanding requirements" will be considered to have been satisfied when the informality has been corrected. A failure to respond within the above-identified time period will result in the application being ABANDONED. **This period for reply is NOT extendable under 37 CFR 1.136(a).**

See attachment(s).

A copy of this notice MUST be returned with the reply. Please address response to "Mail Stop Issue Fee,Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450".

/Joanna Black/
Publication Branch
Office of Data Management
(571) 272-4200

Application No. 10955037

IDENTIFICATION OF SPECIFICATION/DRAWING INCONSISTENCIES

☐ On Page of the specification there is a brief description of FIG. , but the drawings filed do not include a drawing with that designation. Applicant must respond either by supplying the omitted drawing or by amending the specification to remove all references to that drawing.

☐ The drawings filed include FIG. , but the specification's brief description of the drawings does not describe a drawing with that designation. Applicant must respond either by amending the specification to add a brief description of that drawing or by correcting the drawings to remove the drawing in question.

☒ Drawings are present in the application and are referred to in the detailed description of the invention, but the specification does not contain a brief description of the drawings as required by 37 CFR 1.74 and 37 CFR 1.77(b)(8).

☐ Page of the specification refers to FIG. , but no drawing with that designation is described in the brief description of the drawings and no drawing with that designation is present in the application. Applicant must respond either by amending the specification to remove all references to that drawing, or by supplying that drawing and amending the specification to add a brief description of it.

☐ OTHER:

☐ COMMENTS:

PART B -FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571) 273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

30678
CONNOLLY BOVE LODGE & HUTZ LLP
1875 Eye Street, NW
Suite 1100
Washington, DC 20006

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

Shirley Brooks	(Depositor's name)
	(Signature)
8-7-12	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/955,037	09/30/2004	Stephane Bonnet	27592-00987-US	4535

TITLE OF INVENTION: METHOD OF RECONSTRUCTING AN IMAGE WITH DATA ACQUISITION ACCORDING TO SEVERAL IMAGERY MODES

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	no	$1,740.00	$300.00		$2,040.00	08/07/2012

EXAMINER	ART UNIT	CLASS-SUBCLASS
J. W. Lee	2624	382-12800

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- [ ] Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- [ ] "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Connolly Bove Lodge & Hutz LLP
2
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Intellectual Ventures fund 23 LLC

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Las Vegas, Nevada

Please check the appropriate assignee category or categories (will not be printed on the patent): [ ] Individual [X] Corporation or other private group entity [ ] Government

4a. The following fee(s) are enclosed:
- [X] Issue Fee
- [X] Publication Fee (No small entity discount permitted)
- [ ] Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- [ ] A check is enclosed.
- [X] Payment by credit card. Form PTO-2038 is attached.
- [X] The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number 22-0185 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- [ ] a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.
- [ ] b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature /DMMorse/ Date August 7, 2012

Typed or printed name David M. Morse Registration No. 50,505

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:	Group Art Unit: 2624
Stéphane Bonnet et al.	Confirmation No.: 4535
Serial No.: 10/955,037	Examiner: John W. Lee
Filed: September 30, 2004	
For: METHOD OF RECONSTRUCTING AN IMAGE WITH DATA ACQUISITION ACCORDING TO SEVERAL IMAGERY MODES	

AMENDMENT AFTER ALLOWANCE UNDER 37 C.F.R. 1.312

Hon. Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Madam:

Applicants hereby submit this Amendment After Allowance pursuant to 37 CFR 1.312.

A listing of the claims, including amendments thereto, begins on page 2 of this paper.

Remarks begin on page 6 of this paper.

REMARKS

Applicants hereby present a complete listing of the claims to correct inadvertent typographical errors included in claims 15, 16, and 26 found in the listing of the claims filed September 27, 2011. In order to correct these typographical errors, the listing of the claims above have the following changes with respect to the listing of the claims filed September 27, 2011:

- Claims 15 and 16 above are versions of those claims as amended in the listing of the claims filed on March 8, 2011. In the listing of the claims filed September 27, 2011, no amendments were made to claims 15 and 16. The versions of these claims above are the same versions allowed by the Examiner, as claim 15 above includes the language quoted in the Examiner's Reasons for Allowance, mailed on May 7, 2012.
- Claim 26 above is an amended version of the claim based on the version presented in the listing of the claims filed march 8, 2011. Due to the typographical errors included in the amendment filed September 27, 2011, that amendment is being discarded in favor of the amended version presented above. However, the amendment does not substantively alter claim 26—rather the amendment only changes the order of the recited means elements. As amended above, claim 26 reflects the language quoted in the Examiner's Reasons for Allowance, mailed on May 7, 2012. As such, Applicants submit that no substantive issues, whether under 35 U.S.C. §§ 102, 103, or 112, are being raised by the amendment to claim 26 presented above.

For the reasons stated above, Applicants submit that the this amendment should be entered, as no further substantive issues are being raised by the listing of the claims, or the amendment to claim 26, presented above.

Applicants believe no extensions or fees are due with this filing. However, if an extension is needed or a fee is due, please consider this a request therefor and charge Deposit Account No. 03-2775, under Order No. 27592-00987-US, from which the undersigned is authorized to draw.

Dated: August 7, 2012

Respectfully submitted,

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Attorneys for Applicants

Electronic Patent Application Fee Transmittal	
Application Number:	10955037
Filing Date:	30-Sep-2004
Title of Invention:	METHOD OF RECONSTRUCTING AN IMAGE ACQUIRED USING SEVERAL IMAGERY MODES
First Named Inventor/Applicant Name:	Stephane Bonnet
Filer:	David M. Morse/Shirley Brooks
Attorney Docket Number:	27592-00987- US
Filed as Large Entity	

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl issue fee	1501	1	1740	1740
Publ. Fee- early, voluntary, or normal	1504	1	300	300

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**2040**

Electronic Acknowledgement Receipt	
EFS ID:	13438572
Application Number:	10955037
International Application Number:	
Confirmation Number:	4535
Title of Invention:	METHOD OF RECONSTRUCTING AN IMAGE ACQUIRED USING SEVERAL IMAGERY MODES
First Named Inventor/Applicant Name:	Stephane Bonnet
Customer Number:	30678
Filer:	David M. Morse/Shirley Brooks
Filer Authorized By:	David M. Morse
Attorney Docket Number:	27592-00987- US
Receipt Date:	07-AUG-2012
Filing Date:	30-SEP-2004
Time Stamp:	16:05:22
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$2040
RAM confirmation Number	2895
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1		27592-00987US_Issue_Fee_Transmittal_Rule_312Amendment.pdf	383142 63d8fd08d4c63c00af91a3eb2848695cb838d305	yes	8

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Issue Fee Payment (PTO-85B)	1	1
	Amendment after Notice of Allowance (Rule 312)	2	8

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	32139 021736277b9c1cf0576a83bffab3b03c50e7ddc0	no	2

Warnings:

Information:

Total Files Size (in bytes):	415281

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

LISTING OF THE CLAIMS

Applicants hereby present the claims, their status in the application, and amendments thereto as indicated. This listing of the claims replaces all others previously submitted in this application:

15. (Previously Presented) A method of forming an image of a mobile object, comprising:

obtaining a plurality of first images of the mobile object using a first imaging technique while obtaining a plurality of first measurements corresponding to movements of the mobile object using a first sensor system, the first sensor system being independent from the first imaging technique;

associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements;

obtaining a plurality of second images of the mobile object using a second imaging technique while obtaining a plurality of second measurements corresponding to movements of the mobile object using a second sensor system, the second sensor system being independent from the second imaging technique;

associating the plurality of second images with second movement states of the mobile object, the second movement states being determined by the second measurements; and

forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of second images, said associated plurality of second measurements, and said second movement states,

wherein the first imaging technique is different from the second imaging technique.

16. (Previously Presented) The method of Claim 15, further comprising:

time-synchronizing said first plurality of images and said second plurality of images to a common time scale, the common time scale being determined by a comparison between the first and second movement states.

17. (Previously Presented) The method of Claim 15, further comprising:

forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images.

18. (Previously Presented) The method of Claim 17, further comprising:

spatially-synchronizing said first reconstructed images and said second reconstructed images.

19. (Previously Presented) The method of Claim 15, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique.

20. (Previously Presented) The method of Claim 15, further comprising:

spatially-synchronizing the plurality of first images and the plurality of second images using said plurality of first measurements and said plurality of second measurements.

21. (Previously Presented) The method of Claim 15, further comprising:

forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements.

22. (Previously Presented) The method of Claim 21, wherein said forming an image of the mobile object comprises combining said displacement fields.

23. (Previously Presented) The method of Claim 21, wherein said forming displacement fields comprises:

estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields.

24. (Previously Presented) The method of Claim 23, wherein at least one of said movement estimates is formed relative to a reference time.

25. (Previously Presented) The method of Claim 15, wherein the first sensor system is different from the second sensor system.

26. (Currently Amended) An apparatus to form an image of a mobile object, comprising:

means for obtaining a plurality of first images of the mobile object using a first imaging technique;

means for obtaining a plurality of first measurements corresponding to movements of the mobile object while obtaining the plurality of first images, the means for obtaining the plurality of first measurements being independent from the first imaging technique;

means for associating the plurality of first images with first movement states of the mobile object, the first movement states being determined by the first measurements;

means for obtaining a plurality of second images of the mobile object using a second imaging technique;

~~means for associating the plurality of second images with second movement states of the mobile object, the second movement states being determined by the second measurements;~~

means for obtaining a plurality of second measurements corresponding to movements of the mobile object while obtaining the plurality of second images, the means for obtaining the plurality of second measurements being independent from the second imaging technique; [[and]]

means for associating the plurality of second images with second movement states of the mobile object, the second movement states being determined by the second measurements; and

means for forming an image of the mobile object based on said plurality of first images, said associated plurality of first measurements, and said first movement states and on said plurality of said second images, said associated plurality of second measurements, and said second movement states,

wherein the first imaging technique is different from the second imaging technique.

27. (Previously Presented) The apparatus of Claim 26, further comprising:

means for forming first reconstructed images corresponding to said plurality of first images and second reconstructed images corresponding to said plurality of second images.

28. (Previously Presented) The apparatus of Claim 26, wherein said first imaging technique is a radiation attenuation technique and said second imaging technique is a radiation emission technique.

29. (Previously Presented) The apparatus of Claim 26, further comprising:

means for forming displacement fields corresponding, respectively, to said plurality of first images, said plurality of first measurements, said plurality of second images, and said plurality of second measurements.

30. (Previously Presented) The apparatus of Claim 29, wherein said means for forming an image of the mobile object comprises means for combining said displacement fields.

31. (Previously Presented) The apparatus of Claim 29, wherein said means for forming displacement fields comprises:

means for estimating movement of the mobile object based, respectively, on said plurality of first images, said plurality of second images, said plurality of first measurements, and said plurality of second measurements, in order to form said displacement fields.

32. (Previously Presented) The apparatus of Claim 31, wherein at least one of said movement estimates is to be formed relative to a reference time.

33. – 34. (Canceled)

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/955,037	09/30/2004	Stephane Bonnet	27592-00987- US	4535

30678 7590 08/15/2012
CONNOLLY BOVE LODGE & HUTZ LLP
1875 EYE STREET, N.W.
SUITE 1100
WASHINGTON, DC 20006

EXAMINER	
LEE, JOHN W	
ART UNIT	PAPER NUMBER
2624	

MAIL DATE	DELIVERY MODE
08/15/2012	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Response to Rule 312 Communication	Application No.	Applicant(s)
	10/955,037	BONNET ET AL.
	Examiner	Art Unit
	JOHN LEE	2624

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address –

1. ☒ The amendment filed on *7 August 2012* under 37 CFR 1.312 has been considered, and has been:

   a) ☒ entered.

   b) ☐ entered as directed to matters of form not affecting the scope of the invention.

   c) ☐ disapproved because the amendment was filed after the payment of the issue fee.
   Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.

   d) ☐ disapproved. See explanation below.

   e) ☐ entered in part. See explanation below.

/JOHN W. LEE/
Primary Examiner, Art Unit 2624

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/955,037	09/11/2012	8265353	27592-00987- US	4535

30678 7590 08/22/2012

CONNOLLY BOVE LODGE & HUTZ LLP
1875 EYE STREET, N.W.
SUITE 1100
WASHINGTON, DC 20006

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 298 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Stephane Bonnet, Seyssinet-Pariset, FRANCE;
Pierre Grangeat, Saint Ismier, FRANCE;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

Electronic Patent Application Fee Transmittal	
Application Number:	10955037
Filing Date:	30-Sep-2004
Title of Invention:	METHOD OF RECONSTRUCTING AN IMAGE ACQUIRED USING SEVERAL IMAGERY MODES
First Named Inventor/Applicant Name:	Stephane Bonnet
Filer:	Robert Burns Israelsen/Tonya Kusitor
Attorney Docket Number:	27592-00987- US
Filed as Large Entity	

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Certificate of Correction	1811	1	100	100
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
		Total in USD ($)		**100**

Electronic Acknowledgement Receipt	
EFS ID:	15311303
Application Number:	10955037
International Application Number:	
Confirmation Number:	4535
Title of Invention:	METHOD OF RECONSTRUCTING AN IMAGE ACQUIRED USING SEVERAL IMAGERY MODES
First Named Inventor/Applicant Name:	Stephane Bonnet
Customer Number:	30678
Filer:	Robert Burns Israelsen/Tonya Kusitor
Filer Authorized By:	Robert Burns Israelsen
Attorney Docket Number:	27592-00987- US
Receipt Date:	20-MAR-2013
Filing Date:	30-SEP-2004
Time Stamp:	16:05:10
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$100
RAM confirmation Number	2644
Deposit Account	505394
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Certificate of Correction	0815USAP142470_20130320_CoC.pdf	347073 e86c10c3567f6b616f38765111e9f3e9b5ec70ad	no	4
Warnings:					
Information:					
2	Request for Certificate of Correction	0815USAP142470_20130320_RequestLetter.pdf	218802 3de6fc0e6ec92ee4356140513d73e75579b8ca18	no	3
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30308 0bb98939aedeabdd910b3af04c17c8cc651b1bf2	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	596183		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

PATENT NO.: 8,265,353

USPTO CONFIRMATION CODE: 4535

APPLICATION NO.: 10/955,037

FILED: September 30, 2004

EXAMINER: John Lee

GROUP ART UNIT: 2624

FOR: METHOD OF RECONSTRUCTING AN IMAGE ACQUIRED USING SEVERAL IMAGERY MODES

37 CFR 1.322 & 37 CFR 1.323 REQUEST FOR CERTIFICATE OF CORRECTION FOR USPTO AND/OR APPLICANT MISTAKE

Commissioner for Patents
Office of Patent Publication
ATTN: Certificate of Correction Branch
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

A certificate of correction under 35 USC 254 is respectfully requested in the above-identified patent.

It is believed that all errors identified herein were the fault of both the applicant and USPTO and, accordingly, please charge **$100.00** to our Deposit Account No. 50-5394. In the event that a further fee is required, please charge the amount to the same Deposit Account.

The exact locations where the errors appear in the patent and patent application are as follows:

In Column 1, Line 7, delete “synchronisation.” and insert - - synchronization. - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED SEPTEMBER 30, 2004, PAGE 1 (PAGE 782 OF FW), LINE 6)

In Column 2, Line 7, delete “below” and insert - - below. - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED SEPTEMBER 30, 2004, PAGE 3 (PAGE 784 OF FW), LINE 23)

In Column 3, Lines 27-28, delete “synchronisation” and insert - - synchronization - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED SEPTEMBER 30, 2004, PAGE 7 (PAGE 788 OF FW), LINE 4)

In Column 4, Line 28, delete “h_t^{mi}” and insert - - $h_t^{émi}$ - -, therefor.
(AMENDMENTS TO THE SPECIFICATION DATED JULY 10, 2007, PAGE 4 OF 16 (PAGE 583 OF FW), LINE 11)

In Column 6, Lines 31-33, delete “ $\left| \begin{matrix} (h_1^{att} \quad h_2^{att}, moD)(h_1^{émi} \quad h_2^{émi}, m) \\ (m_{att}, moD)(m_{émi}, m) \end{matrix} \right.$ ” and insert - - $\left| \begin{matrix} (h_1^{att}, h_2^{att}, moD)\ (h_1^{émi}, h_2^{émi}, m) \\ (m_{att}, moD)\ (m_{émi}, m) \end{matrix} \right.$ - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED SEPTEMBER 30, 2004, PAGE 14 (PAGE 795 OF FW), LINES 19-20)

In Column 6, Lines 40-42, delete
“ $\left\{ \begin{matrix} aE_1(g_1, g_2, m_{émi}) + bE_2(f_1, f_2, moD) + cE_3(\mathrm{mg}, m) + \\ dE_4(mf, moD) + eE_5(h_1^{émi} \quad h_2^{émi}, m) + fE_6(h_1^{att} \quad h_2^{att}, moD) + \\ gE_7(m_{émi}, m) + hE_8(m_{att}, moD) + iE_9(m) \end{matrix} \right\}$ ” and
insert - -
$\left\{ \begin{matrix} a\ E_1(g_1, g_2, m_{émi}) + b\ E_2\ (f_1, f_2, moD) + c\ E_3(mg, m) + d\ E_4(mf, moD) \\ + e\ E_5(h_1^{émi}, h_2^{émi}, m) + f\ E_6(h_1^{att}, h_2^{att}, moD) + g\ E_7(m_{émi}, m) + h\ E_8(m_{att}, moD) \\ + i\ E_9(m) \end{matrix} \right\}$
- -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED SEPTEMBER 30, 2004, PAGE 15 (PAGE 796 OF FW), LINES 1-3)

Volkswagen Exhibit 1002, Page 852 of 885

In Column 7, Line 58, delete "TEP" and insert - - PET - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED SEPTEMBER 30, 2004, PAGE 18 (PAGE 799 OF FW), LINE 5)

In Column 8, Line 11, in Claim 1, delete "object using" and insert - - object, the first movement states being determined by - -, therefor.
(AMENDMENTS TO THE CLAIMS DATED AUGUST 7, 2012, PAGE 2, CLAIM 15, LINE 8)

In Column 8, Line 23, in Claim 1, delete "movement measurements," and insert - - measurements, - -, therefor.
(AMENDMENTS TO THE CLAIMS DATED AUGUST 7, 2012, PAGE 2, CLAIM 15, LINE 17)

In Column 8, Line 25, in Claim 1, delete "movement measurements," and insert - - measurements, - -, therefor.
(AMENDMENTS TO THE CLAIMS DATED AUGUST 7, 2012, PAGE 2, CLAIM 15, LINE 18)

In Column 8, Lines 31-32, in Claim 2, delete "scale based on" and insert - - scale, the common time scale being determined by a comparison between - -, therefor.
(AMENDMENTS TO THE CLAIMS DATED AUGUST 7, 2012, PAGE 2, CLAIM 16, LINES 3-4)

The requested corrections are attached on Form PTO/SB/44.

Dated this 20th day of March, 2013.

Respectfully Submitted,

/R. Burns Israelsen/ Reg. # 42,685
R. BURNS ISRAELSEN
Acting in Representative Capacity
(37 CFR 1.34)
Registration No. 42,685
Telephone No. (435) 252-1360

PTO/SB/44 (09-07)
Approved for use through 08/31/2013. OMB 0651-0033
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UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 8,265,353 B2

APPLICATION NO. : 10/955,037

ISSUE DATE : September 11, 2012

INVENTOR(S) : Bonnet, et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In Column 1, Line 7, delete "synchronisation." and insert - - synchronization. - -, therefor.

In Column 2, Line 7, delete "below" and insert - - below. - -, therefor.

In Column 3, Lines 27-28, delete "synchronisation" and insert - - synchronization - -, therefor.

In Column 4, Line 28, delete "h_t^{mi}" and insert - - $h_t^{émi}$ - -, therefor.

MAILING ADDRESS OF SENDER (Please do not use customer number below):

Maschoff Gilmore & Israelsen
1441 West Ute Boulevard, Suite 100
Park City, UT 84098 United States

This collection of information is required by 37 CFR 1.322, 1.323, and 1.324. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1.0 hour to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Attention Certificate of Corrections Branch, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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In Column 6, Lines 31-33, delete "$\left| \begin{matrix} (h_1^{att} \quad h_2^{att}, moD)(h_1^{émi} \quad h_2^{émi}, m) \\ (m_{att}, moD)(m_{émi}, m) \end{matrix} \right.$" and

insert - - $\left| \begin{matrix} (h_1^{att}, h_2^{att}, moD)\ (h_1^{émi}, h_2^{émi}, m) \\ (m_{att}, moD)\ (m_{émi}, m) \end{matrix} \right.$ - -, therefor.

In Column 6, Lines 40-42, delete

"$\left\{ \begin{matrix} aE_1(g_1, g_2, m_{émi}) + bE_2(f_1, f_2, moD) + cE_3(\mathrm{mg}, m) + \\ dE_4(mf, moD) + eE_5(h_1^{émi} \quad h_2^{émi}, m) + fE_6(h_1^{att} \quad h_2^{att}, moD) + \\ gE_7(m_{émi}, m) + hE_8(m_{att}, moD) + iE_9(m) \end{matrix} \right\}$" and

insert - -

$$\left\{ \begin{matrix} a\ E_1(g_1, g_2, m_{émi}) + b\ E_2\ (f_1, f_2, moD) + c\ E_3(mg, m) + d\ E_4(mf, moD) \\ + e\ E_5(h_1^{émi}, h_2^{émi}, m) + f\ E_6(h_1^{att}, h_2^{att}, moD) + g\ E_7(m_{émi}, m) + h\ E_8(m_{att}, moD) \\ + i\ E_9(m) \end{matrix} \right\}$$

-, therefor.

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Park City, UT 84098 United States

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UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 8,265,353 B2

APPLICATION NO. : 10/955,037

ISSUE DATE : September 11, 2012

INVENTOR(S) : Bonnet, et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In Column 7, Line 58, delete "TEP" and insert - - PET - -, therefor.

In Column 8, Line 11, in Claim 1, delete "object using" and insert - - object, the first movement states being determined by - -, therefor.

In Column 8, Line 23, in Claim 1, delete "movement measurements," and insert - - measurements, - -, therefor.

In Column 8, Line 25, in Claim 1, delete "movement measurements," and insert - - measurements, - -, therefor.

In Column 8, Lines 31-32, in Claim 2, delete "scale based on" and insert - - scale, the common time scale being determined by a comparison between - -, therefor.

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Maschoff Gilmore & Israelsen
1441 West Ute Boulevard, Suite 100
Park City, UT 84098 United States

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If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 8,265,353 B2
APPLICATION NO. : 10/955037
DATED : September 11, 2012
INVENTOR(S) : Bonnet et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Specifications:

In Column 1, Line 7, delete "synchronisation." and insert -- synchronization. --, therefor.

In Column 2, Line 7, delete "below" and insert -- below. --, therefor.

In Column 3, Lines 27-28, delete "synchronisation" and insert -- synchronization --, therefor.

In Column 4, Line 28, delete "h_t^{mi}" and insert -- $h_t^{émi}$ --, therefor.

In Column 6, Lines 31-33, delete "$\begin{vmatrix} (h_1^{att} \quad h_2^{att}, moD)(h_1^{émi} \quad h_2^{émi}, m) \\ (m_{att}, moD)(m_{émi}, m) \end{vmatrix}$" and insert -- $\begin{vmatrix} (h_1^{att}, h_2^{att}, moD)\ (h_1^{émi}, h_2^{émi}, m) \\ (m_{att}, moD)\ (m_{émi}, m) \end{vmatrix}$ --, therefor.

In Column 6, Lines 40-42, delete "$\left\{ \begin{array}{l} aE_1(g_1, g_2, m_{émi}) + bE_2(f_1, f_2, moD) + cE_3(mg, m) + \\ dE_4(mf, moD) + eE_5(h_1^{émi} \quad h_2^{émi}, m) + fE_6(h_1^{att} \quad h_2^{att}, moD) + \\ gE_7(m_{émi}, m) + hE_8(m_{att}, moD) + iE_9(m) \end{array} \right\}$" and insert -- $\left\{ \begin{array}{l} a\ E_1(g_1, g_2, m_{émi}) + b\ E_2\ (f_1, f_2, moD) + c\ E_3(mg, m) + d\ E_4(mf, moD) \\ + e\ E_5(h_1^{émi}, h_2^{émi}, m) + f\ E_6(h_1^{att}, h_2^{att}, moD) + g\ E_7(m_{émi}, m) + h\ E_8(m_{att}, moD) \\ + i\ E_9(m) \end{array} \right\}$ --, therefor.

In Column 7, Line 58, delete "TEP" and insert -- PET --, therefor.

Signed and Sealed this
Twenty-first Day of May, 2013

Teresa Stanek Rea
Acting Director of the United States Patent and Trademark Office

In the Claims:

In Column 8, Line 11, in Claim 1, delete "object using" and insert -- object, the first movement states being determined by --, therefor.

In Column 8, Line 23, in Claim 1, delete "movement measurements," and insert -- measurements, --, therefor.

In Column 8, Line 25, in Claim 1, delete "movement measurements," and insert -- measurements, --, therefor.

In Column 8, Lines 31-32, in Claim 2, delete "scale based on" and insert -- scale, the common time scale being determined by a comparison between --, therefor.

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PATENT AND TRADEMARK OFFICE

P.O. Box 1450
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www.uspto.gov

ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
10/955,037	**11/20/2024 02:48:26 AM Z ET**	**27592-00987- US**

Title of Invention

METHOD OF RECONSTRUCTING AN IMAGE ACQUIRED USING SEVERAL IMAGERY MODES

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	8265353
CONFIRMATION #	4535	FILED BY	Jialin Zhong
PATENT CENTER #	68032624	FILING DATE	09/30/2004
CUSTOMER #	30678	FIRST NAMED INVENTOR	Stephane Bonnet
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	-

Documents

TOTAL DOCUMENTS: 2

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
Longhorn POA81.a.pdf	2	Power of Attorney	658 KB
Longhorn_373c.pdf	3	Assignee showing of ownership per 37 CFR 3.73	123 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
Longhorn POA81.a.pdf	0DF4CE70114179AA4AA5D2865BFB6CAFF2574F706C03EFEC 5C409ED735AFFB2306DB8839D1033198529CACE16F5E445F8 E3406142ED495CE21135A255134F8A7
Longhorn_373c.pdf	00C2CCD493D8FAA4D2EC4FC3A34A2B9FB0823A51A618B82E 28B4F93AE0550BCF56499DF4655764A867AE2EC1C8B9377CC

A551393D32033EE78A78242BD922504

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/AIA/81A (02-15)
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PATENT - POWER OF ATTORNEY OR REVOCATION OF POWER OF ATTORNEY WITH A NEW POWER OF ATTORNEY AND CHANGE OF CORRESPONDENCE ADDRESS

Patent Number	8,265,353
Issue Date	2012-9-11
First Named Inventor	STEPHANE BONNET
Title	Method of Reconstructing an Image Acquired Using Several Imagery Modes
Attorney Docket No.	27592-00987- US

I hereby revoke all previous powers of attorney given in the above-identified patent.

☐ A Power of Attorney is submitted herewith.

OR

☐ I hereby appoint Practitioner(s) associated with the Customer Number identified in the box at right as my/our attorney(s) or agent(s) with respect to the patent identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

OR

☒ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s) with respect to the patent identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

Practitioner(s) Name	Registration Number
Peter Lambrianakos	58279
Jialin Zhong	62937
Vincent Rubino	68594
Enrique Iturralde	72883

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Address					
City		State		Zip	
Country					
Telephone		Email			

I am the:

☐ Applicant.

OR

☒ Patent owner.

Statement under 37 CFR 3.73(c) (Form PTO/AIA/96) submitted herewith or filed on _____.

SIGNATURE of Applicant or Patent Owner

Signature	Thomas Schweitzer	Date	11/19/24
Name	Thomas Schweitzer	Telephone	(936) 319-7022
Title and Company	Manager of Longhorn Automotive Group LLC		

NOTE: Signatures of all the applicants or patent owners of the entire interest or their representative(s) are required. If more than one signature is required, submit multiple forms, check the box below, and identify the total number of forms submitted in the blank below.

☐ A total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public, which is to update (and by the USPTO to process) the file of a patent or reexamination proceeding. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

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1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: LONGHORN AUTOMOTIVE GROUP LLC

Application No./Patent No.: 8,265,353 Filed/Issue Date: 2012-9-11

Titled: METHOD OF RECONSTRUCTING AN IMAGE ACQUIRED USING SEVERAL IMAGERY MODES

LONGHORN AUTOMOTIVE GROUP LLC, a Limited Liability Company

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

B. ☑ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: STEPHANE BONNET, PIERRE GRANGEAT To: COMMISSARIAT A L'ENERGIE ATOMIQUE

   The document was recorded in the United States Patent and Trademark Office at

   Reel 016709, Frame 0700, or for which a copy thereof is attached.

2. From: COMMISSARIAT A L'ENERGIE ATOMIQUE To: INTELLECTUAL VENTURE FUND 23 LLC

   The document was recorded in the United States Patent and Trademark Office at

   Reel 020403, Frame 0558, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
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Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

3. From: INTELLECTUAL VENTURE FUND 23 LLC To: XYLON LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 036192, Frame 0620, or for which a copy thereof is attached.

4. From: XYLON LLC To: INTELLECTUAL VENTURES ASSETS 195 LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 065015, Frame 0562, or for which a copy thereof is attached.

5. From: INTELLECTUAL VENTURES ASSETS 195 LLC To: AI-CORE TECHNOLOGIES, LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 065207, Frame 0371, or for which a copy thereof is attached.

6. From: AI-CORE TECHNOLOGIES, LLC To: LONGHORN AUTOMOTIVE GROUP LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 066911, Frame 0261, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☑ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Jialin Zhong/	2024-11-20
Signature	Date
Jialin Zhong	62,937
Printed or Typed Name	Title or Registration Number

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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PATENT - POWER OF ATTORNEY OR REVOCATION OF POWER OF ATTORNEY WITH A NEW POWER OF ATTORNEY AND CHANGE OF CORRESPONDENCE ADDRESS

Patent Number	8,265,353
Issue Date	2012-9-11
First Named Inventor	STEPHANE BONNET
Title	Method of Reconstructing an Image Acquired Using Several Imagery Modes
Attorney Docket No.	27592-00987- US

I hereby revoke all previous powers of attorney given in the above-identified patent.

☐ A Power of Attorney is submitted herewith.

OR

☐ I hereby appoint Practitioner(s) associated with the Customer Number identified in the box at right as my/our attorney(s) or agent(s) with respect to the patent identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

OR

☒ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s) with respect to the patent identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

Practitioner(s) Name	Registration Number
Jialin Zhong	62937

Please recognize or change the correspondence address for the above-identified patent to:

☐ The address associated with the above-identified Customer Number.

OR

☒ The address associated with the Customer Number identified in the box at right: 155075

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the:

☐ Applicant.

OR

☒ Patent owner.

Statement under 37 CFR 3.73(c) (Form PTO/AIA/96) submitted herewith or filed on _____.

SIGNATURE of Applicant or Patent Owner

Signature	Thomas Schweitzer	Date	11/21/24
Name	Thomas Schweitzer	Telephone	(516) 319-7022
Title and Company	Manager of Longhorn Automotive Group LLC		

NOTE: Signatures of all the applicants or patent owners of the entire interest or their representative(s) are required. If more than one signature is required, submit multiple forms, check the box below, and identify the total number of forms submitted in the blank below.

☐ A total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public, which is to update (and by the USPTO to process) the file of a patent or reexamination proceeding. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
10/955,037	**11/21/2024 07:50:41 PM Z ET**	**27592-00987- US**

Title of Invention

METHOD OF RECONSTRUCTING AN IMAGE ACQUIRED USING SEVERAL IMAGERY MODES

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	8265353
CONFIRMATION #	4535	FILED BY	Jialin Zhong
PATENT CENTER #	68070614	FILING DATE	09/30/2004
CUSTOMER #	172615	FIRST NAMED INVENTOR	Stephane Bonnet
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	-

Documents

TOTAL DOCUMENTS: 2

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
Longhorn POA81A.pdf	1	Power of Attorney	1650 KB
Longhorn_373c.pdf	3	Assignee showing of ownership per 37 CFR 3.73	123 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
Longhorn POA81A.pdf	39EE9F7C23B8B9F7378A1793803DC7E0F0518B5D1F7C61412 DE01CBE94B771BE834B8CBABB11FA7F4E44F56A027B5B2D9 96E6FB8CA9B1820911A8559A135C91E
Longhorn_373c.pdf	00C2CCD493D8FAA4D2EC4FC3A34A2B9FB0823A51A618B82E 28B4F93AE0550BCF56499DF4655764A867AE2EC1C8B9377CC

A551393D32033EE78A78242BD922504

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/AIA/96 (08-12)
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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: LONGHORN AUTOMOTIVE GROUP LLC

Application No./Patent No.: 8,265,353 Filed/Issue Date: 2012-9-11

Titled: METHOD OF RECONSTRUCTING AN IMAGE ACQUIRED USING SEVERAL IMAGERY MODES

LONGHORN AUTOMOTIVE GROUP LLC, a Limited Liability Company

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

B. ☑ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: STEPHANE BONNET, PIERRE GRANGEAT To: COMMISSARIAT A L'ENERGIE ATOMIQUE

   The document was recorded in the United States Patent and Trademark Office at

   Reel 016709, Frame 0700, or for which a copy thereof is attached.

2. From: COMMISSARIAT A L'ENERGIE ATOMIQUE To: INTELLECTUAL VENTURE FUND 23 LLC

   The document was recorded in the United States Patent and Trademark Office at

   Reel 020403, Frame 0558, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/96 (08-12)
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STATEMENT UNDER 37 CFR 3.73(c)

3. From: INTELLECTUAL VENTURE FUND 23 LLC To: XYLON LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 036192, Frame 0620, or for which a copy thereof is attached.

4. From: XYLON LLC To: INTELLECTUAL VENTURES ASSETS 195 LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 065015, Frame 0562, or for which a copy thereof is attached.

5. From: INTELLECTUAL VENTURES ASSETS 195 LLC To: AI-CORE TECHNOLOGIES, LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 065207, Frame 0371, or for which a copy thereof is attached.

6. From: AI-CORE TECHNOLOGIES, LLC To: LONGHORN AUTOMOTIVE GROUP LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 066911, Frame 0261, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☑ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Jialin Zhong/	2024-11-20
Signature	Date
Jialin Zhong	62,937
Printed or Typed Name	Title or Registration Number

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
10/955,037	09/30/2004	Stephane Bonnet	27592-00987- US

CONFIRMATION NO. 4535

30678
POLSINELLI PC
(DC OFFICE)
PO Box 140310
Kansas City, MO 64114-0310

POWER OF ATTORNEY NOTICE

OC000000081001183

Date Mailed: 11/25/2024

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 11/20/2024.

- The Power of Attorney to you in this application has been revoked by the applicant. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/sltorres/

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
10/955,037	09/30/2004	Stephane Bonnet	27592-00987- US

CONFIRMATION NO. 4535

172615
Fabricant LLP
411 Theodore Fremd Road
Suite 206 South
Rye, NY 10580

POA ACCEPTANCE LETTER

OC000000081001239

Date Mailed: 11/25/2024

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 11/20/2024.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/sltorres/

UNITED STATES PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

PETITON TO ACCEPT UNINTENTIONAL DELAYED PAYMENT OF MAINTENANCE FEE (37 CFR 1.378(b))

APPLICATION #	FIRST NAMED INVENTOR	ATTORNEY DOCKET #	FILING DATE
10955037	Stephane Bonnet	27592-00987- US	09/30/2004

Title of Invention

METHOD OF RECONSTRUCTING AN IMAGE ACQUIRED USING SEVERAL IMAGERY MODES

In re Patent #: 8265353
Issue date: 09/11/2012}

The delay in the payment of the maintenance fee to the above-identified patent was unintentional.

PETITIONER(S) REQUEST THAT THE DELAYED PAYMENT OF THE MAINTENANCE FEE BE ACCEPTED AND THE PATENT REINSTATED

(1) Petition fee under 37 CFR 1.17(m) is attached

Applicant claims the following entity status
Regular Undiscounted

(2) Statement
The delay in the payment of the maintenance fee to this patent was unintentional

- Petitioner(s) is reminded that a delay resulting from a deliberately chosen course of action or a change in circumstance is not an unintentional delay.

- Petitioner(s) is further reminded that a person seeking reinstatement of an expired patent should not make a statement that the delay in payment of the maintenance fee was unintentional unless the entire delay was unintentional, including the period from discovery that the maintenance fee was not timely paid until payment of the maintenance fee. For example, a statement that the delay in payment of the maintenance fee was unintentional would not be proper when the patentee becomes aware of an unintentional failure to timely pay the maintenance fee and then intentionally delays filing a petition for reinstatement of the patent under 37 CFR 1.378. See MPEP 2590.

NOTE: Where the petition under 37 CFR 1.378 is filed more than two years after the date the patent expired for nonpayment of the maintenance fee, the United States Patent and Trademark Office requires an additional explanation of the circumstances

surrounding the delay that establishes the entire delay was unintentional. This requirement is in addition to the requirement to provide a statement that the entire delay was unintentional. See Clarification of the Practice for Requiring Additional Information in Petitions Filed in Patent Applications and Patents Based on Unintentional Delay, 85 FR 12222 (March 2, 2020). See MPEP 711.03(c)(II)(C)-(F) for additional guidance on the information required to establish that the entire delay was unintentional.

Signature

I certify, in accordance with 37 CFR 1.4(d)(4) that I am:
An attorney or agent registered to practice before the Patent and Trademark Office who has been given power of attorney in this application

Signature	Name	Registration #
/Jialin Zhong/	Jialin Zhong	62937

PETAUTO SB64.0

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
10/955,037	**12/05/2024 01:58:20 PM Z ET**	**27592-00987- US**

Title of Invention

METHOD OF RECONSTRUCTING AN IMAGE ACQUIRED USING SEVERAL IMAGERY MODES

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	8265353
CONFIRMATION #	4535	FILED BY	Eddie Rowell
PATENT CENTER #	68242216	FILING DATE	09/30/2004
CUSTOMER #	155075	FIRST NAMED INVENTOR	Stephane Bonnet
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Jialin Zhong

Documents

TOTAL DOCUMENTS: 1

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
petition-request.pdf	2	ePetition Request Form	27 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
petition-request.pdf	9E3496CE8894E137F609533B99350CF94872D2AE5179A663D2 8817420C666B47844F5416B4CEF6D4C37F69F9CC708599DCE 96ED59FAB86682BA430632D3C71E0

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES
PATENT AND TRADEMARK OFFICE

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Alexandria, VA 22313 - 1450
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ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
10/955,037	**12/05/2024 01:58:20 PM Z ET**	**27592-00987- US**

Title of Invention

METHOD OF RECONSTRUCTING AN IMAGE ACQUIRED USING SEVERAL IMAGERY MODES

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	8265353
CONFIRMATION #	4535	FILED BY	Eddie Rowell
PATENT CENTER #	68242216	AUTHORIZED BY	Jialin Zhong
CUSTOMER #	155075	FILING DATE	09/30/2004
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Stephane Bonnet

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
CARD / 9633	**E2024B5D58427605**	**Jialin Zhong**

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
1553	MAINTENANCE FEE DUE AT 11.5 YEARS	7700.00	1	7700.00
1558	PETITION FOR THE DELAYED PAYMENT OF THE FEE FOR MAINTAINING A PATENT IN FORCE	2100.00	1	2100.00
			TOTAL AMOUNT:	**$9,800.00**

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

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Receipt will establish the filing date of the application

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
10/955,037	09/30/2004	Stephane Bonnet	27592-00987- US

CONFIRMATION NO. 4535

155075
Zhong Law, LLC
51 JFK Parkway
1st Floor West
Short Hills, NJ 07078

POA ACCEPTANCE LETTER

OC000000081475873

Date Mailed: 12/06/2024

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 11/21/2024.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/fasrat/

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United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
10/955,037	09/30/2004	Stephane Bonnet	27592-00987- US

CONFIRMATION NO. 4535

POWER OF ATTORNEY NOTICE

OC000000081475643

172615
Fabricant LLP
411 Theodore Fremd Road
Suite 206 South
Rye, NY 10580

Date Mailed: 12/06/2024

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 11/21/2024.

- The Power of Attorney to you in this application has been revoked by the applicant. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/fasrat/

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/955,037	09/30/2004	Stephane Bonnet	27592-00987- US	4535

155075 7590 01/24/2025

Zhong Law, LLC
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Short Hills, NJ 07078

EXAMINER	
LEE, JOHN W	

ART UNIT	PAPER NUMBER
2624	

NOTIFICATION DATE	DELIVERY MODE
01/24/2025	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ip@remotedocket.com
szhao@zhong-law.com
zhong@zhong-law.com

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

In re Patent No.: 8,265,353	:	
Issue Date: 11 Sep 2012	:	
Application No. 10/955,037	:	
Filed: 30 Sep 2004	:	DECISION ON PETITION
For: METHOD OF RECONSTRUCTING	:	
AN IMAGE ACQUIRED USING	:	
SEVERAL IMAGERY MODES	:	

This is a decision on the petition under 37 CFR 1.378(b), filed December 5, 2024, as an ePetition, to accept the unintentionally delayed payment of a maintenance fee for the above-identified patent. While the ePetition has now been placed into the Image File Wrapper, no decision was rendered with the ePetition filed December 5, 2024.

The petition is **GRANTED**.

With this decision, the maintenance fee records and the application file of the above-identified patent have been updated to reflect that the ePetition to accept the unintentionally delayed payment of the 11.5 year maintenance fee under 37 CFR 1.378(b) filed on December 5, 2024 has been granted.

The rules and statutory provisions governing the operations of the U.S. Patent and Trademark Office require payment of a fee on filing each petition under 37 CFR § 1.378(b). In this instance, the fees required are $7,700 for the maintenance fee due at 11.5 years and $2,100 for the delayed payment of the fee due at 11.5 years. The total fee owed is $9,800. Petitioner submitted a payment of $9,800 on December 5, 2024.

It is not apparent whether the person signing the statement of unintentional delay was in a position to have firsthand or direct knowledge of the facts and circumstances of the delay at issue. Nevertheless, such statement is being treated as having been made as the result of a reasonable inquiry into the facts and circumstances of such delay. See 37 CFR 11.18 and Changes to Representation of Others Before the United States Patent and Trademark Office; Final Rule Notice, 73 Fed. Reg. 47650 (August 14, 2008), 1334 Off. Gaz. Pat. Office 338 (September 9, 2008). In the event that such an inquiry has not been made, petitioner must make such an inquiry. If such inquiry results in the discovery that it is not correct that the entire delay

in filing the required reply from the due date for the reply until the filing of a grantable petition pursuant to 37 CFR 1.378 was unintentional, petitioner must notify the Office.

Telephone inquiries concerning this matter may be directed to Vanitha Elgart at 571.272.7395.

/VANITHA M ELGART/
Petitions Examiner, OPET