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(54) **METHODS AND SYSTEM FOR INTELLIGENT QUALITATIVE AND QUANTITATIVE ANALYSIS FOR MEDICAL DIAGNOSIS**

VERFAHREN UND SYSTEM ZUR INTELLIGENTEN QUALITATIVEN UND QUANTITATIVEN ANALYSE FÜR DIE MEDIZINISCHE DIAGNOSE

METHODES ET SYSTEME POUR ANALYSE QUALITATIVE ET QUANTITATIVE INTELLIGENTE EN VUE D'UN DIAGNOSTIC MEDICAL

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Description

[0001] This Application is based on U.S. Provisional Application No. 60/494,802 filed August 14, 2003, and U.S. Utility Patent Application entitled **Methods and System for Intelligent Qualitative and Quantitative Analysis for Medical Diagnosis** by inventors Jianzhong QIAN, Guo-Qing WEI and Li FAN filed in the U.S. Patent and Trademark Office on August 12, 2004.

BACKGROUND

1. Field of Invention

[0002] The present invention relates to systems and methods for medical information processing and analysis. Specifically, the present invention relates to intelligent qualitative and quantitative analysis of medical information for medical decision making.

2. Description of Related Art

[0003] In disease diagnosis using modern imaging techniques, physicians are often overwhelmed by the amount of information made available through different acquisition devices. Such devices may include, but are not limited to, ultrasound (US), Computerized Tomography (CT), and Magnet Resonance Imaging (MRI). Diagnostic information (DI), may differ from patient data and it may include key diagnostic evidence identified from diagnostic data that directly or indirectly supports and/or disaffirms a physician/specialist's hypothesis about a diagnosis. Often, important diagnostic information relevant to a specific disease is buried in the huge volume of data. In addition, although patient records and laboratory test results, such as blood tests, may provide important clues to suspected diseases/abnormalities, the interpretation of such information is not conventionally integrated with various image-based diagnosis processes in a coherent fashion. Consequently, physicians have to look manually for all disease-relevant information embedded in both non-visual and visual data from different sources. This task is labor intensive and requires a high level of skill. In addition, a manual process is also subject to mistakes, which may lead to misdiagnosis due to either negligence or lack of skill, qualitative and quantitative measurements, as well as intuitive visualization means that allow a physician to seamlessly integrate information across multi-modalities into a clinic workflow.

[0004] Another problem of the prior art is that conventional Computer Aided Detection/Diagnosis (CAD) systems usually allow a physician to access only either a computer's output in the form of binary decisions or raw data. That is, a wide variety of rich DI that can be derived between the raw data and the binary decision output (i.e., yes or no decisions) is ignored or discarded. Since such a loss is irreversible, the physician does not have the opportunity to interactively and quantitatively examine or identify suspicious regions, with the assistance of a computer system, in order to make their independent decision.

[0005] A third problem with conventional CAD systems is that multi-modality information, including both non-visual and visual information, is not utilized simultaneously. Current CAD systems usually operate on data of a single modality.

[0006] FIG. **1** illustrates a flowchart of a conventional computer-aided detection system, in which a physician starts, at 104, by selecting a patient image of a particular modality with respect to a pre-defined disease. **At 106,** a computer detects suspicious regions in the image that may correspond to where a specific disease manifests itself. The result of such computer detection is a binary yes/no decision for each location in the image. When the computer indicates the existence of an abnormality in an image location, a mark may be displayed, at 108, near the corresponding location in the image. **At 110,** the physician makes diagnostic decisions based on the computer derived marks.

[0007] In addition to the above, J.-Z. QIAN discloses in "Intelligent Diagnostic Imaging and Analysis for Radiology" (FRONTIERS IN BIOMEDICAL ENGINEERING; 1ST ANNUAL WORDL CONGRESS OF CHINESE BIOMEDICAL ENGINEERS; WCCBME 2002, dated December 11, 2002;) and in "Information Fusion for Automatic Lesion Detection in Diagnostic Image Analysis" (PRIS 2002 - PROCEEDIGNS OF THE 2ND INTERNATIONAL WORKSHOP ON PATTERN RECOGNITION IN INFORMATION SYSTEMS. IN CONJUNCTION WITH ICEIS 2002, 1 April 2002 (2002-04-01), pages 33-44, Alicante, Spain) an intelligent diagnostic imaging and analysis system. This teaching is related to processing visual and non-visual diagnostic information for providing this processed diagnostic information to uncertainty reasoning and fusion in hyper-space. Further, a hierarchical structure among a plurality of visual information spaces is considered. However, the respective teachings do not consider the generation of matrices of diagnostic information that are dynamically and hierarchically organized.

SUMMARY OF THE INVENTION

[0008] According to aspects of the present invention there are provided a method for analyzing medical information according to claim 1, a system for analyzing medical information according to claim 6, and a machine readable medium according to claim 8 having instructions stored thereon where the instructions, when accessed, enable for analyzing medical information. Further embodiments of the present invention are described in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The present invention is further described in

terms of exemplary embodiments, which will be described in detail with reference to the drawings. These drawings are non-limiting exemplary embodiments, in which like reference numerals represent similar parts throughout the several views of the drawings, and wherein:

FIG. **1** illustrates a flowchart of a conventional computer-aided detection system;

FIG. **2** depicts an exemplary high-level block diagram of an Intelligent Qualitative and Quantitative Analysis system, according to one embodiment of the present invention;

FIG. **3** depicts an exemplary construct of a Dynamic Matrix of Diagnostic Decision (Dynamic MDD) in relation to other parts of an Intelligent Qualitative and Quantitative Analysis system, according to one embodiment of the present invention;

FIG. **4** shows an exemplary construct of a Diagnostic Data Search Engine and Diagnostic Info Extractor in relation to other parts, according to one embodiment of the present invention;

FIG. **5** shows an exemplary construct of a non-visual Diagnostic Data Search Engine and DI Extractor in relation to other parts, according to one embodiment of the present invention;

FIG. **6** shows an exemplary construct of a visual Diagnostic Data Search Engine and DI Extractor in relation to other parts, according to one embodiment of the present invention;

FIG. **7** illustrates the overall operation of an IQQA system, according one embodiment of the invention; and

FIG. **8** is a flowchart of an exemplary process, in which an intelligent qualitative and quantitative analysis system facilitates a user to perform patient-specific and disease-specific multimodality diagnostic information based medical decision making, according to one embodiment of the present invention.

DETAILED DESCRIPTION

[0010] An Intelligent Qualitative and Quantitative Analysis (IQQA) system is disclosed, which is aimed at systematically extracting and integrating diagnostic information from various sources. The system may be deployed on a general or a special purpose computer and adapted to any specific computing environment. The IQQA is a diagnostic-information-oriented computerized system that dynamically embeds different information processing and disease-specific applications into optimal clinical workflow. Such information processing and applications may include, but are not limited to, diagnostic data searching, diagnostic information (DI) extraction, DI quantification, DI visualization, DI fusion, as well as diagnosis of abnormalities and/or diseases based on data across multi-modality/multi-information type. Functionalities may be dynamically embedded through, for example, a) selectively activating functionalities based on a type of disease under investigation; b) dynamically forming a disease-specific workflow driven by specific diagnostic information available; and c) adaptively integrating physician's case-specific knowledge and experience of physicians gained during computer-human real-time interaction with previously built-in domain-specific knowledge to expand the knowledge base of the system in performing a diagnosis.

[0011] The IQQA system as described herein provides a wealth of information between raw diagnostic data and a binary diagnostic decision, thereby to assist physicians to make diagnostic decisions more effectively with potentially a higher precision. A Dynamic Matrix of Diagnostic Decision (dynamic MDD) platform, is designed to facilitate various functionalities such as extraction, presentation, navigation, visualization, fusion, and modification of, and interaction with diagnostic information.

[0012] The IQQA as described herein provides an interactive, intelligent qualitative and quantitative analysis of diagnostic data across all modalities from different sources to assist physicians to make a diagnostic decision. FIG **2** depicts an exemplary high level block diagram 200 of the IQQA, according to a preferred embodiment of the present invention. The system **200** comprises a patient info storage **225** and a disease info storage **225,** a plurality of databases **210-a,** ..., **210-b,** a Diagnostic Data Search Engine and DI Extractor **240,** a Dynamic Matrix of Diagnostic Decision (dynamic MDD) **260,** an original data space **250,** a diagnostic report generation mechanism **255,** and a diagnostic report storage **265.** The Dynamic MDD **260** comprises of a plurality of dynamic DI matrices **230-1, 230-2,** and **230-1,** and an Interactive Diagnostic Decision Making Mechanism (IDDM) **235.**

[0013] In operation, a physician may first select a disease type, through the IDDM mechanism **235,** from the disease information storage **220** and a patient ID or patient name from the patient information storage **225.** Such information is used to start a patient-specific and disease-specific diagnostic data searching process. To do so, the patient information and disease information may be fed to the Diagnostic Data (DD) Search Engine and Diagnostic Information (DI) Extractor **240.** The DD search engine and DI extractor **240** then searches for diagnostic data related to the given patient and disease from different databases, e.g., database 1 **210-a,** ..., database N **210-b** and extracts Disease Specific (DS) and Patient Specific (PS) DI, including visual and non-visual, from the searched diagnostic data. The databases searched may include local, remote, or distributed databases. Such databases may be accessible through any communication channels, including, but not limited to, a Local Area Network (LAN), a Wide Area Network (WAN), an Intranet, the Internet, a proprietary network, or a wireless network. The diagnosis decision produced by the IDDM mechanism 235 may be selectively fedback into the disease type storage **220** so that new disease types may be saved

and utilized in the future.

[0014] Through the Dynamic Matrix of Diagnostic Decision (dynamic MDD) platform **260,** the physician may make an interactive diagnostic decision. First, the extracted DI may be constructed in the form of DI matrices **230,** which may be represented as a set of hierarchically organized dynamic matrices such as the dynamic DI matrix 1 **230-1,** the dynamic DI matrix 2 **230-2,** ..., and dynamic DI matrix *i* **230-3.** The interactive diagnostic decision making mechanism **235** may facilitate the physician to explore the DI space, to perform DI extraction or re-extraction, DI modification, and/or DI fusion. The physician may rely on the dynamic diagnostic information represented by such matrices presented using interactive tools embedded in these dynamic MDDs **260** to reach a diagnostic decision. A diagnostic report 265 may also be generated through the diagnostic report generation mechanism **255.**

[0015] FIG. **3** depicts an exemplary construct of the Dynamic Matrix of Diagnostic Decision (dynamic MDD) **260,** according to an embodiment of the present invention. The Dynamic MDD **260** is a platform for physicians to perform real-time interactive diagnostic decision making. The Dynamic MDD **260** comprises a plurality of DI matrices **230,** a DI storage mechanism **302,** a DI grouping mechanism **304,** a DI presentation mechanism **306,** a DI navigation mechanism **308,** a DI retrieving mechanism **310,** a DI re-extraction mechanism **312,** a DI modification mechanism **314,** and a DI fusion mechanism **316.**

[0016] The DI storage mechanism **302** is for storing diagnostic information. For example, for each suspicious region/volume of interest (ROI or VOI) associated with a specific disease, one or more dynamic DI matrices may be generated. These dynamic DI matrices may store key DI/evidence about the disease extracted from both non-visual and visual data around the ROI/VOI.

[0017] The DI grouping mechanism **304** is for organizing the extracted DI. Dynamic DI matrices **230** are a set of dynamically and hierarchically organized tables, constructed based on, e.g., anatomical, physiological, and biomedical knowledge and categories. It may also be grouped based on body parts, e.g., the entire body, a specific organ, some parts of the organ, biomarks, tissues, and molecules. Cells in the matrices may contain dynamic links to different sources of DI and/or the patient's raw diagnostic data. A matrix of a certain level may be embedded in its parent matrix at a higher level, except for the root matrix. Information contained in a matrix at each level may be systematically fused into its parent matrix one level above. The contained matrix hierarchy may be designed so that the most important diagnostic information related to making a diagnostic decision may be presented in the upper-most level, and more detailed DI information appears at lower levels. That is, an upper level matrix may provide an overview of the diagnostic information of the levels below, whereas the lower level matrices provide supporting information which further explains the items in the upper level table.

[0018] The DI presentation mechanism **306** is for presenting information in the DI matrices to the user in different forms. The DI in the Dynamic MDD may be presented either qualitatively or quantitatively. The presentation may be in a variety of formats, including, but are not limited to, numerals, strings, graphs, charts, colors, curves, and pictures. Representative images and results from computer analysis may be organized according to their relevance to the disease and may be directly visualized in one or more cells of a Dynamic DI matrix. The format and appearance of a Dynamic DI Matrix may be dynamically configured according to different criteria, such as the disease type selected, the image modality under examination, or the acquisition protocol. DI measurements that are considered abnormal may be highlighted using different colors in the dynamic DI matrices.

[0019] The DI navigation mechanism **308** provides means for a physician to explore the DI space. The DI may be organized in such a manner so that users may navigate in the DI space freely in real-time as needed. Through the DI navigation mechanism **308,** a physician can explore information in DI matrices at any level by activating a desired matrix, bringing information into the physician's view via a simple mouse click on the corresponding items in the DI hierarchy. A user may also go back to the original DI data for re-examination or inspection, either qualitatively or quantitatively. In addition, a global view of the navigation trail may also be visualized while a user is exploring the DI space.

[0020] The DI retrieving mechanism **310** is for retrieving DI stored previously. The retrieved DI may be loaded into the Dynamic DI Matrices **230.** A comparison between the current DI and previously stored DI may also be made.

[0021] The DI re-extraction mechanism **312** may be activated by a user to re-extract DI from previously saved ROI or VOI images to facilitate understanding and comparison with the current DI.

[0022] The DI modification mechanism **314** may be activated by a physician to make changes to extracted DI. For example, when a physician feels that a piece of DI extracted by the DD Search Engine and DI Extractor **240** is inaccurate or wrong, the physician may modify the DI by clicking on the corresponding cell in the dynamic DI matrix and then enter revisions. A set of interactive analytical tools and visualization tools encapsulated within the extracted visual DI may be activated and presented to the physician. The physician may then incorporate personal knowledge in the analysis procedure interactively. For example, a physician may interactively control the analysis/visualization tools through manual adjustment of their parameters. The physician may also directly edit certain items in the dynamic DI matrices and/or add new items and diagnostic comments into the matrices.

[0023] The DI fusion mechanism **316** for fusing domain-specific knowledge in the built-in IQQA system and a physician's case-specific knowledge. This may be achieved through a hierarchical decision making, man-

machine real-time interaction and information exchanging process. In other words, dynamic MDD **260** in the IQQA makes all qualitative and quantitative diagnostic information transparent to physicians in their diagnostic decision making process. The information fusion methods provided by the DI fusion mechanism **316** are embedded in each hierarchical level of the DI presentation. Such fusion may also be performed across different levels. Disease-specific knowledge may be incorporated in the dynamic MDD **260** through information fusion, visualization and display. The DI fusion mechanism may employ patient and disease specific knowledge as well as non-patient specific disease specific knowledge to compute alert levels for each DI or abnormalities, lesions, cancers, or other diseases detected either by the system or by physicians. The dynamic MDD **260** may take into account a physician's preference and case-specific knowledge in a diagnostic decision making process by fusing the physician's knowledge with the built-in domain-specific knowledge in the IQQA system during the physician's real-time interaction with the dynamic MDD **260.**

[0024] FIG **4** shows an exemplary construct of the DD Search Engine and DI Info Extractor **240** in relation to other parts, according to one embodiment of the present invention. A non-visual DD Search Engine and DI Exactor **404** may search different databases **406 - 408** for non-visual diagnostic data and extract non-visual diagnostic information **410.** Such databases may include local, remote, and distributed databases, and may be accessed through a communication channel. A visual DD Search Engine and DI Extractor **405** may search the databases **406** - **408** for visual diagnostic data and extract visual diagnostic information **412.**

[0025] In addition to patient specific data, the non-visual DD Search Engine and DI extractor **404** may also search for non-patient-specific, but disease specific information across the different databases to, for example, bring the most up-to-date statistics about the disease into the IQQA decision support process. Such information may be utilized in different ways. For example, such information maybe integrated in the IQQA's qualitative and quantitative analysis process. Knowledge about the disease may also be used to build and update any internal diagnostic model for a corresponding disease within IQQA. Furthermore, when physicians have direct access to such up-to-date statistical information about specific diseases, they can interpret the information, based on his/her own experience and knowledge, and rely on such interpretation in the decision making process.

[0026] The search results returned by the DD Search Engine and DI extractor **240** may be presented to a user in the form of, for example, file trees. The user may choose one of the files for further review. Alternatively, the user may exercise discretion to view all the studies in a sequential fashion. Those disease and patient specific, disease and non-patient specific diagnostic data may include both non-visual data or visual data. Non-visual data may comprise patient record, blood test results, and genotype data. Visual data may comprise diagnostic images of different modalities (e.g., CT, MRI, X-ray), and pathological images.

[0027] FIG **5** shows an exemplary construct of the non-visual DD search engine and DI extractor **404** in relation to other parts, according to one embodiment of the invention. A non-visual data search engine **504** is deployed to search for non-visual diagnostic data. Such a search engine may be any commercial or off-the-shelf search engine, implemented in any language such as SQL. Based on the searched non-visual data, a disease-specific non-visual diagnostic evidence extractor **506** may extract one or more pieces of disease-specific key evidence. Such extraction may be guided by a disease-specific evidence template **508** that pre-defines what constitutes key evidence given a disease type. After the key evidence is extracted, an automatic key evidence analyzer **510** may be used to analyze the key evidence. Statistical measurements of corresponding evidence may be retrieved from a database **512** and used to evaluate the extracted key evidence. Such statistical measurements may be derived based on studies over a statistically significant population so that they can be used to evaluate the significance of the key evidence extracted. For example, each piece of patient specific key evidence may be compared with the statistical range of the same evidence present in the database **512.** Evidences with measures that are beyond the given normal range, **514,** may then be stored in a non-visual DI storage **410.**

[0028] In addition to the key evidence analysis, a risk factor analyzer **516** may further analyze the risk factors associated with the patient with respect to the given a disease type based on information related to the patient, such as age, sex, medication record, blood test or family history. The output **518** of such analysis may also provide estimated degrees of impact of these risk factors on the hypothesized disease or lesion.

[0029] FIG **6** shows an exemplary construct of the visual DD search engine and DI extractor **405** according to an embodiment of the present invention. A visual DD search engine **604** performs a search for all visual data related to specific patient and disease, such as, CT data, MRI data, and X-ray data. Such data forms a multi-modality, multi-dimensional data set **606.** Here multi-dimensionality may include both spatial and temporal dimensions. Various visual DI extraction functions, according to the present invention, may be performed while a physician navigates through an imagery subspace, e.g., in selected 2D, 3D, 4D, or higher dimensional sub-space created by each of the modalities in real-time or near real-time interactively.

[0030] In the depicted exemplary embodiment, there comprises a DI-based enhancement mechanism **608,** a cross-modality DI extraction mechanism **614,** a computer-aided DI quantification mechanism **616,** and a cross-modality fusion-based abnormality detection mechanism **618.** These visual DI extractors may extract both qualitative and quantitative diagnostic information. For exam-

ple, to obtain qualitative visual DI, the DI-based enhancement mechanism **608** enhances diagnostic information contained in the imageries. Based on global or local anatomic and disease information as well as information extracted in corresponding locations of other imageries, the DI-based enhancement mechanism **608** may automatically determine what is the most focused DI for the given specific disease in the given image and compute feature statistics about suspicious regions detected either by the system or by the user. Such statistics may be used to automatically set the enhancement parameters to bring the best visible diagnostic information to the eyes of a physician for diagnosis purposes. A user can choose to apply a global disease-specific enhancement via a global enhancement mechanism **610** to enhance an entire image set, based on information gathered from both non-visual DI and other available visual DI, including, but not limited to, statistics about shape, size, and brightness of all suspicious regions. A user can also choose to use a local enhancement mechanism **612** to enhance each local suspicious region of interest. Parameters used in enhancement may be computed based on DI information about individual suspicious region of interest and the disease.

[0031] Visual DI may also be extracted via the cross-modality DI extraction process **614.** Multi-modality and multi-dimensional information may be exploited in such a way that DI extracted from one modality or dimension may be used to confirm or disaffirm DI in another modality or dimension. Patient and disease specific, as well as non-patient specific and disease specific non-visual information may also be used to aid such visual DI extraction process. For example, age and sex may be used to determine focus regions of suspicion for a specific disease. Visual DI extraction and/or re-extraction may be performed automatically or interactively in real-time by physicians. In an interactive extraction process, a physician may apply his/her own knowledge to the extraction process. For example, a physician may make some manual adjustment to already extracted DI by adjusting parameters that are used by the DI extraction process.

[0032] Visual DI may also be quantified via the computer-aided DI quantification (CAQ) mechanism **616.** The CAQ mechanism **616** is capable of automatically quantifying DI across multiple modalities. Such quantification may be applied to measurements such as size, shape, and intensity variations of suspicious regions within and across multimodalities.

[0033] Visual DI may also be extracted via the cross-modality fusion-based abnormality detection mechanism **618.** A physician may pose different hypotheses or sub-hypotheses about diseases, including both disease type and disease location, to the system based upon, e.g., spatial reasoning or temporal reasoning about the extracted DI in the hierarchically organized DI space. Cross-modality fusion, according to the present invention, may be performed in different modes. For example, fusion can be performed based on positional or DI information. In the positional fusion mode, visual data cross different modalities and dimensions are registered prior to the fusion. In a DI fusion mode, fusion is based on the nature of the information contained in the DI space.

[0034] FIG. 7 illustrates the overall operational scheme of the IQQA system, according one embodiment of the invention. First, a user **700** selects a patient ID from an existing patient ID list, or enter a patient ID **703.** The user may also select a disease type **704.** With the patient ID **703** and disease type **704,** a Diagnostic Data Search Engine **706** automatically identifies all available diagnostic data, both patient-specific and non-patient specific, that is relevant to the specified disease from one or more relevant databases **702,** either local, remote, or distributed. Such identified diagnostic data may be non-visual or visual, including genotype data **740,** lab test results **742,** phenotype data **744,** and pathological data **746.** The retrieved patient and non-patient specific and disease-specific data may then be organized according to some pre-defined criteria. For example, data type and date of examination may be used to organize the retrieved data.

[0035] The search for diagnostic data may be conducted via an on-line search **750** or via an off-line search **748.** An on-line search may be performed while a physician interacts with the IQQA system during a diagnostic decision making process. An off-line search may be performed before the physician starts the diagnosis process via the IQQA system. The search results may be presented to the user in the form of, for example, file trees **707** so that a user may choose one or more of the files for further review **(710).** A DI extraction and quantification mechanism **708** may extract diagnostic information from the diagnostic data with respect to the specified disease. The patient and disease-specific, as well as non-patient specific and disease specific data and the extracted diagnostic information may be made accessible to a user during a diagnosis session. The user may manually examine, if needed simultaneously, all the accessible diagnostic data and diagnostic information associated with the selected patient at the same time.

[0036] The extracted diagnostic information may then be organized hierarchically in one or more dynamic DI matrix/matrices in a diagnostic information space **716** according to some pre-determined criteria such as degree of details of the lesion, parts of the body where disease occurs.

[0037] The user **700** may further interact with the dynamic DI matrices in the diagnostic information space **716** via an interactive decision making mechanism **724.** The user **700** may also choose to load dynamic DI matrices generated from previous exams **711** of the same patient and merged with the current DI matrices. Decisions may be made also in the context of the previous DI matrices.

[0038] The dynamic DI matrices in the DI space 716 offers an information space where a physician may navigate to identify rich information from different modalities and along different dimensions, all at different levels of

detail. A physician may navigate in the diagnostic information space **716** in a Real-Time Interactive (RTI) mode in either an imagery sub-space or a DI sub-space. The imagery sub-space may further include 2D image sub-space, 3D image sub-space, or image sub-space in higher dimensions. A physician may select to operate in any sub-space according to needs. While navigating in the diagnostic information space **716,** a user may also navigate at different levels of detail, exploring and searching for diagnostic information that may be relevant to diagnostic decision making.

[0039] Diagnostic information may be presented to the user **700** after appropriate processing such as information fusion, visualization, and real-time user interaction of the dynamic MDD. The user **700** may perform RTI image space navigation **712,** RTI visual DI extraction and quantification **718,** or RTI DI-space navigation **720.** During real time user interaction, the user **700** may also re-extract existing DI or make modifications to existing DI **(722).** Through RTI decision making **726,** the user can make diagnostic decisions **728.**

[0040] Information contained in different dynamic DI matrices may be compiled to generate a report **734** by a diagnostic report generation mechanism **732**. Such a generated report may be particularly structured based on some specified requirements, which may be automatically set up as default or may be dynamically updated by the user **700.** The generated report **734** may contain hyperlinks associated with a medical decision included in the report **734** connecting to the original images or other diagnostic information that are used in reaching the underlying medical decision. The hyperlinks included in the report **734** may also embed some integrated mechanisms that may be launched to provide the capability of displaying, navigation, or reviewing of the supporting diagnostic information. When the user **700** completes the examination, the dynamic DI matrices **730** derived during the current examination may be stored for future use.

[0041] FIG. **8** is a flowchart of an exemplary process, in which the IQQA system facilitates a user to reach a medical decision using diagnostic information from different sources, according to one embodiment of the invention. After the system is started, a user may select a patient name or patient ID at **804,** and a disease type at **806.** At **808,** patient-specific and disease-specific, and non-patient-specific and disease-specific diagnostic data is retrieved from one or more databases. From the diagnostic data, non-visual DI may be extracted at **810,** and visual DI may be extracted at **812.** The extracted DI is stored in dynamic DI matrices at **814.** Based on the extracted DI from different sources, modalities, and dimensions, dynamic fusion is performed based on diagnostic needs at **816.** Such a dynamic fusion may be carried out via either an automatic or an interactive process. At **818,** diagnostic decisions may then be made based on the dynamically fused DI. At **820,** a diagnostic report is generated. Such a report may include information automatically generated based on DI, such as summary of key evidence or statistics. The generated report may also include information entered by a physician. After a physician makes relevant diagnostic decisions, associated DI may be archived and stored, at **822,** for future reference.

Claims

1. A method for analyzing medical information, comprising:

specifying (804, 806) identifying information including a patient identification and a disease type to be used to obtain medically-related information including patient-specific and disease-specific information, wherein the medically-related information includes visual medical information and non-visual information;

searching (808), automatically, the medically-related information acquired from different sources based on the identifying information;

analyzing the medically-related information to generate an analysis result associated with the disease type, said analyzing comprising:

extracting (812) diagnostic evidence associated with the disease type from the medically-related information and/or enhanced information thereof obtained by enhancing a medical image included in the medically-related information, wherein the diagnostic evidence to be extracted is determined in an automated mode, and wherein said extracting is performed across different modalities of the medically-related information,

evaluating, in the automated mode, a feature derived from the medically-related information,

detecting an abnormality candidate based on the medically-related information, and

identifying patient-specific risk factors based on the medically-related information,

wherein said evaluating is a quantitative evaluation including at least one of:

estimating size of a region in a medical image corresponding to the abnormality,

estimating statistics related to intensity distribution within a region of the abnormality,

determining a change with respect to an aspect of the abnormality occurred over time, and

determining texture of the abnormality,

generating, by a diagnostic decision matrix plat-

form, a plurality of matrices (230) of diagnostic information by fusing (816) different types of the medically-related information and the analysis result thereof,
wherein the plurality of matrices of diagnostic information is organized as a hierarchy, and constructed based on at least one criterion associated with the patient,
wherein cells in the matrices include links corresponding to different sources from which diagnostic information is retrieved, and
wherein a first matrix at a first level of the hierarchy, which is a parent matrix of a second matrix at a second level in the hierarchy, includes an amount of diagnostic information that is less detailed than the amount of diagnostic information included in the second matrix, and
wherein said fusing combines different types of the medically-related information across different levels of the hierarchy based on the disease type and the patient identification;
providing a navigation mechanism (308) for allowing a user to navigate through information contained in the plurality of matrices of diagnostic information;
providing a modification mechanism (314) that may be activated by a user to update the extracted diagnostic information, wherein the matrices of diagnostic information embed an interactive tool that is activated to update parameters associated with the diagnostic information included in the matrices;
making (818) a medical diagnostic decision based on the plurality of matrices of diagnostic information; and
generating (820) a report based on the medical diagnostic decision, wherein the report includes a link associating the medical diagnostic decision to diagnostic information represented in the plurality of matrices.

2. The method according to claim 1, wherein the visual medical information includes medical images acquired in a space of a certain dimension.

3. The method according to claim 2, wherein the certain dimension of the space includes at least one of two-dimensions and three-dimensions.

4. The method according to claim 1, wherein the non-visual information includes at least one of:

a medical test result;
genotype information;
personal medical history;
risk factors related to personal life style and behaviors;
phenotype or pathological information;
family medical history; and
general medical knowledge.

5. The method according to claim 1, wherein the different sources include:

a CT scan;
an X-ray examination;
a PET scan;
a SPECT scan;
a nuclear medicine examination;
an MRI scan;
a sonogram;
a DNA or molecular imaging procedure;
a blood test;
a physical examination; and
any combination thereof.

6. A system (200) for analyzing medical information, comprising:

an interface configured to facilitate selection of identifying information;
a search engine (240. 706) configured to search medically-related information acquired from different sources based on the selected identifying information, wherein the search engine searches patient-specific and disease-specific medically-related information with respect to a selected patient identification and a selected disease type;
a diagnostic information extractor (240, 708) configured to analyze the medically-related information and identify medical evidence associated with a selected disease type,
wherein the diagnostic information extractor is configured to extract diagnostic evidence associated with the disease type from the medically-related information and/or enhanced information thereof obtained by enhancing a medical image included in the medically-related information wherein the diagnostic evidence to be extracted is determined in an automated mode, and wherein said extracting is performed across different modalities of the medically-related information;
a dynamic diagnostic decision matrix platform (260, 724) configured to facilitate generating a plurality of matrices (230) of diagnostic information by fusing different types of the medically-related information and the analysis result thereof wherein the plurality of matrices of diagnostic information is organized as a hierarchy and constructed based on at least one criterion associated with the patient, and wherein cells in the matrices include links corresponding to different sources from which diagnostic information is retrieved, and wherein a first matrix at a first level

in the hierarchy, which is a parent matrix of a second matrix at a second level in the hierarchy, includes an amount of diagnostic information that is less than the amount of diagnostic information included in the second matrix, and wherein said fusing combines different types of the medically-related information across different levels of the hierarchy based on the disease type and the patient identification,
a diagnostic information navigation mechanism (308) configured to facilitate navigating through diagnostic information represented by the plurality of matrices;
a diagnostic information modification mechanism (314) that may be activated by a user to update the extracted diagnostic information, wherein the matrices of diagnostic information embed an interactive tool that is activated to update parameters associated with the diagnostic information included in the matrices; and
a medical report generation mechanism (255, 732) configured to produce a medical report reporting a medical decision, wherein the medical report includes a link associating the medical diagnostic decision to diagnostic information represented in the plurality of matrices.

7. The system according to claim 6, wherein the diagnostic information extractor includes a patient-specific risk factor analyzer configured to identify patient-specific risk factors based on the medically-related information.

8. A machine readable medium having instructions stored thereon where the instructions, when accessed, enable the performance of the method according to one of the claims 1 to 5.

Patentansprüche

1. Verfahren zum Analysieren medizinischer Informationen, umfassend:

Angeben (804, 806) identifizierender Informationen, die eine Patientenidentifikation und einen Krankheitstyp umfassen, die zu verwenden sind, um Informationen mit medizinischem Zusammenhang zu erhalten, die patientenspezifische und krankheitsspezifische Informationen umfassen, wobei die Informationen mit medizinischem Zusammenhang visuelle medizinische Informationen und nicht-visuelle Informationen umfassen;
automatisches Durchsuchen (808) der Informationen mit medizinischem Zusammenhang, die von verschiedenen Quellen erfasst wurden, basierend auf den identifizierenden Informationen;

Analysieren der Informationen mit medizinischem Zusammenhang zum Erzeugen eines Analyseergebnisses, das dem Krankheitstyp zugehörig ist, wobei das Analysieren Folgendes umfasst:

Extrahieren (812) diagnostischer Hinweise, die dem Krankheitstyp zugehörig sind, von den Informationen mit medizinischem Zusammenhang und/oder verbesserten Informationen davon, die durch Verbessern eines medizinischen Bildes erhalten werden, das in den Informationen mit medizinischem Zusammenhang umfasst ist, wobei die zu extrahierenden diagnostischen Hinweise auf eine automatisierte Art bestimmt werden, und wobei das Extrahieren über verschiedene Modalitäten der Informationen mit medizinischem Zusammenhang durchgeführt wird,
Bewerten eines von den Informationen mit medizinischem Zusammenhang abgeleiteten Merkmals auf die automatisierte Art,
Ermitteln eines Anomaliekandidaten basierend auf den Informationen mit medizinischem Zusammenhang, und
Identifizieren patientenspezifischer Risikofaktoren basierend auf den Informationen mit medizinischem Zusammenhang,
wobei das Bewerten eine quantitative Bewertung ist, die mindestens eines von Folgendem umfasst:

Schätzen der Größe einer Region in einem medizinischen Bild, die der Anomalie entspricht,
Schätzen einer Statistik, die die Intensitätsverteilung innerhalb einer Region der Anomalie betrifft,
Bestimmen einer Änderung in Bezug zu einem Aspekt der Anomalie, die im Laufe der Zeit eingetreten ist, und
Bestimmen der Textur der Anomalie,

Erzeugen einer Vielzahl von Matrizes (230) von diagnostischen Informationen durch Vereinigen (816) verschiedener Typen von den Informationen mit medizinischem Zusammenhang und deren Analyseergebnis mittels einer diagnostischen Entscheidungsmatrix-Plattform,
wobei die Vielzahl von Matrizes von diagnostischen Informationen als eine Hierarchie organisiert ist und basierend auf mindestens einem Kriterium konstruiert ist, das dem Patienten zugehörig ist,
wobei Zellen in den Matrizes Verbindungen umfassen, die verschiedenen Quellen entsprechen, von denen diagnostische Informationen

abgerufen werden, und
wobei eine erste Matrix auf einer ersten Ebene der Hierarchie, die eine übergeordnete Matrix einer zweiten Matrix auf einer zweiten Ebene in der Hierarchie ist, eine Menge von diagnostischen Informationen umfasst, die weniger detailliert ist als die Menge von diagnostischen Informationen, die in der zweiten Matrix umfasst ist, und
wobei das Vereinigen verschiedene Typen der Informationen mit medizinischem Zusammenhang über verschiedene Ebenen der Hierarchie basierend auf dem Krankheitstyp und der Patientenidentifikation kombiniert;
Bereitstellen eines Navigationsmechanismus (308), um es einem Benutzer zu ermöglichen, durch Informationen zu navigieren, die in der Vielzahl von Matrizes von diagnostischen Informationen enthalten sind;
Bereitstellen eines Abwandlungsmechanismus (314), der durch einen Benutzer aktiviert werden kann, um die extrahierten diagnostischen Informationen zu aktualisieren, wobei die Matrizes von diagnostischen Informationen ein interaktives Werkzeug einbetten, das aktiviert wird, um Parameter zu aktualisieren, die den diagnostischen Informationen zugehörig sind, die in den Matrizes umfasst sind;
Treffen (818) einer medizinischen diagnostischen Entscheidung basierend auf der Vielzahl von Matrizes von diagnostischen Informationen; und
Erzeugen (820) eines Berichts basierend auf der medizinischen diagnostischen Entscheidung, wobei der Bericht eine Verbindung umfasst, die die medizinische diagnostische Entscheidung mit diagnostischen Informationen verknüpft, die in der Vielzahl von Matrizes dargestellt sind.

2. Verfahren nach Anspruch 1, wobei die visuellen medizinischen Informationen medizinische Bilder umfassen, die in einem Raum mit einer gewissen Dimension erfasst wurden.

3. Verfahren nach Anspruch 2, wobei die bestimmte Dimension des Raumes mindestens eines von zwei Dimensionen und drei Dimensionen umfasst.

4. Verfahren nach Anspruch 1, wobei die nicht-visuellen Informationen mindestens eines von Folgendem umfassen:

ein medizinisches Testergebnis;
Genotyp-Informationen;
persönliche Anamnese;
Risikofaktoren in Verbindung mit dem persönlichen Lebensstil und Verhaltensweisen;
Phänotyp- oder pathologische Informationen;
Familienanamnese; und
allgemeines medizinisches Wissen.

5. Verfahren nach Anspruch 1, wobei die verschiedenen Quellen Folgendes umfassen:

eine CT-Tomographie;
eine Röntgenuntersuchung;
eine PET-Tomographie;
eine SPECT-Tomographie;
eine nuklearmedizinische Untersuchung;
eine MRT-Tomographie;
ein Sonogramm;
ein DNA- oder molekulares Bildgebungsverfahren;
einen Bluttest;
eine körperliche Untersuchung; und
irgendeine Kombination davon.

6. System (200) zum Analysieren medizinischer Informationen, umfassend:

eine Schnittstelle, die ausgestaltet ist, die Auswahl von identifizierenden Informationen zu erleichtern;
eine Suchmaschine (240, 706), die ausgestaltet ist, Informationen mit medizinischem Zusammenhang, die von unterschiedlichen Quellen erfasst wurden, basierend auf den ausgewählten identifizierenden Informationen zu durchsuchen, wobei die Suchmaschine patientenspezifische und krankheitsspezifische Informationen mit medizinischem Zusammenhang in Bezug auf eine ausgewählte Patientenidentifikation und einen ausgewählten Krankheitstyp durchsucht;
eine Extrahierungsvorrichtung (240, 708) für diagnostische Informationen, die ausgestaltet ist, die Informationen mit medizinischem Zusammenhang zu analysieren und medizinische Hinweise zu identifizieren, die einem ausgewählten Krankheitstyp zugehörig sind,
wobei die Extrahierungsvorrichtung für diagnostische Informationen ausgestaltet ist, diagnostische Hinweise, die dem Krankheitstyp zugehörig sind, von den Informationen mit medizinischem Zusammenhang und/oder verbesserten Informationen davon, die durch Verbessern eines medizinischen Bildes erhalten werden, das in den Informationen mit medizinischem Zusammenhang umfasst ist, zu extrahieren, wobei die zu extrahierenden diagnostischen Hinweise auf eine automatische Art bestimmt werden und wobei das Extrahieren über verschiedene Modalitäten der Informationen mit medizinischem Zusammenhang durchgeführt wird;
eine dynamische diagnostische Entscheidungs-

matrix-Plattform (260, 724), die ausgestaltet ist, das Erzeugen einer Vielzahl von Matrizes (230) von diagnostischen Informationen durch Vereinigen verschiedener Typen von den Informationen mit medizinischem Zusammenhang und deren Analyseergebnis zu erleichtern, wobei die Vielzahl von Matrizes von diagnostischen Informationen als eine Hierarchie organisiert ist und basierend auf mindestens einem Kriterium konstruiert ist, das dem Patienten zugehörig ist, und wobei Zellen in den Matrizes Verbindungen umfassen, die verschiedenen Quellen entsprechen, von denen diagnostische Informationen abgerufen werden, und wobei eine erste Matrix auf einer ersten Ebene in der Hierarchie, die eine übergeordnete Matrix einer zweiten Matrix auf einer zweiten Ebene in der Hierarchie ist, eine Menge von diagnostischen Informationen umfasst, die kleiner als die Menge von diagnostischen Informationen ist, die in der zweiten Matrix umfasst ist, und wobei das Vereinigen verschiedene Typen von den Informationen mit medizinischem Zusammenhang über verschiedene Ebenen der Hierarchie basierend auf dem Krankheitstyp und der Patientenidentifikation kombiniert,

einen diagnostischen Informationsnavigationsmechanismus (308), der ausgestaltet ist, das Navigieren durch diagnostische Informationen zu erleichtern, die durch die Vielzahl von Matrizes dargestellt werden;

einen diagnostischen Informationsabwandlungsmechanismus (314), der durch einen Benutzer aktiviert werden kann, um die extrahierten diagnostischen Informationen zu aktualisieren, wobei die Matrizes von diagnostischen Informationen ein interaktives Werkzeug einbetten, das aktiviert wird, um Parameter zu aktualisieren, die den diagnostischen Informationen zugehörig sind, die in den Matrizes umfasst sind; und

einen medizinischen Berichtserzeugungsmechanismus (255, 732), der ausgestaltet ist, einen medizinischen Bericht zu erzeugen, der über eine medizinische Entscheidung berichtet, wobei der medizinische Bericht eine Verbindung umfasst, die die medizinische diagnostische Entscheidung mit diagnostischen Informationen verknüpft, die in der Vielzahl von Matrizes dargestellt sind.

7. System nach Anspruch 6, wobei die Extrahierungsvorrichtung für diagnostische Informationen eine patientenspezifische Risikofaktor-Analysevorrichtung umfasst, die ausgestaltet ist, patientenspezifische Risikofaktoren basierend auf den Informationen mit medizinischem Zusammenhang zu identifizieren.

8. Maschinenlesbarer Datenträger, der Befehle darauf gespeichert aufweist, wobei die Befehle, wenn darauf zugegriffen wird, das Durchführen des Verfahrens nach einem der Ansprüche 1 bis 5 ermöglichen.

Revendications

1. Méthode d'analyse d'informations médicales, consistant à :

spécifier (804, 806) des informations d'identification comprenant une identification de patient et un type de maladie à utiliser pour obtenir des informations médicalement associées comprenant des informations particulières au patient et particulières à la maladie, dans laquelle les informations médicalement associées comprennent des informations médicales visuelles et des informations non visuelles ;

chercher (808), automatiquement, les informations médicalement associées acquises de différentes sources basées sur les informations d'identification ;

analyser les informations médicalement associées pour générer un résultat d'analyse associé au type de maladie, ladite analyse consistant à :

extraire (812) des preuves diagnostiques associées au type de maladie à partir des informations médicalement associées et/ou d'informations améliorées de celles-ci obtenues en améliorant une image médicale comprise dans les informations médicalement associées, dans lesquelles la preuve diagnostique à extraire est déterminée dans un mode automatisé, et dans laquelle ladite extraction est réalisée parmi différentes modalités des informations médicalement associées,

évaluer, dans le mode automatisé, une caractéristique dérivée des informations médicalement associées,

détecter une anomalie candidate basée sur les informations médicalement associées, et

identifier des facteurs de risques particuliers au patient basés sur les informations médicalement associées,

dans laquelle ladite évaluation est une évaluation quantitative comprenant au moins une action parmi les suivantes :

estimer la taille d'une région dans une image médicale correspondant à l'anomalie,

estimer une statistique reliée à la réparation de l'intensité dans une région de l'anomalie,

déterminer un changement relatif à un aspect de l'anomalie survenu au fil du temps, et
déterminer une texture de l'anomalie,

générer, par une plateforme de matrice de décision diagnostique, une pluralité de matrices (230) d'informations diagnostiques en fusionnant (816) différents types des informations médicalement associées et le résultat de l'analyse de celle-ci,
dans laquelle la pluralité de matrices d'informations diagnostiques est organisée comme une hiérarchie et construite en fonction d'au moins un critère associé au patient,
dans laquelle des cellules dans les matrices comprennent des liens correspondant aux différentes sources depuis lesquelles les informations diagnostiques sont extraites, et
dans laquelle une première matrice à un premier niveau de la hiérarchie, laquelle est une matrice parente d'une seconde matrice à un second niveau dans la hiérarchie, comprend une quantité d'informations diagnostiques qui est moins détaillée que la quantité d'informations diagnostiques comprises dans la seconde matrice, et
dans laquelle ladite fusion combine différents types d'informations médicalement associées parmi différents niveaux de la hiérarchie selon le type de maladie et l'identification du patient ;
fournir un mécanisme de navigation (308) pour permettre à un utilisateur de naviguer dans les informations contenues dans la pluralité de matrices d'informations diagnostiques ;
fournir un mécanisme de modification (314) qui peut être activé par un utilisateur pour mettre à jour les informations diagnostiques extraites, dans lequel les matrices d'informations diagnostiques sont intégrées dans un outil interactif qui est activé pour la mise à jour de paramètres associés avec les informations diagnostiques comprises dans les matrices ;
prendre (818) une décision diagnostique médicale basée sur la pluralité de matrices d'informations diagnostiques ; et
générer (820) un rapport basé sur la décision diagnostique médicale, dans laquelle le rapport comprend un lien associant la décision diagnostique médicale à des informations diagnostiques représentées dans la pluralité de matrices.

2. Méthode selon la revendication 1, dans laquelle les informations médicales visuelles comprennent des images médicales acquises dans un espace d'une certaine dimension.

3. Méthode selon la revendication 2, dans laquelle la certaine dimension de l'espace comprend au moins une de deux dimensions et de trois dimensions.

4. Méthode selon la revendication 1, dans laquelle les informations non visuelles comprennent au moins un parmi :

résultat de test médical ;
informations sur le génotype ;
antécédents médicaux personnels ;
facteurs de risque liés au style de vie personnel et aux comportements ;
informations pathologiques ou sur le phénotype ;
antécédents médicaux familiaux ; et
connaissances médicales générales.

5. Méthode selon la revendication 1, dans laquelle les différentes sources comprennent :

un tomodensitogramme ;
un examen aux rayons X ;
un examen de TEP ;
un scanneur SPECT ;
un examen de médecine nucléaire ;
une IRM ;
un sonogramme ;
une procédure d'imagerie moléculaire ou d'ADN ;
un test sanguin ;
un examen physique ; et
toute combinaison de ceux-ci.

6. Système (200) d'analyse d'informations médicales, comprenant :

une interface configurée pour faciliter la sélection des informations d'identification ;
un moteur de recherche (240, 706) configuré pour rechercher des informations médicalement associées acquises de différentes sources basées sur les informations d'identification sélectionnées,
dans lequel le moteur de recherche recherche des informations médicalement associées particulières au patient et particulières à la maladie par rapport à une identification de patient sélectionnée et à un type de maladie sélectionné ;
un extracteur d'informations diagnostiques (240, 708) configuré pour analyser les informations médicalement associées et identifier les preuves médicales associées à un type de maladie sélectionné,
dans laquelle l'extracteur d'informations diagnostiques est configuré pour extraire des preuves diagnostiques associées au type de maladie à partir des informations médicalement associées et/ou d'informations améliorées de celles-ci obtenues en améliorant une image médicale

comprise dans les informations médicalement associées dans lesquelles la preuve diagnostique à extraire est déterminée dans un mode automatisé, et dans lesquelles ladite extraction est réalisée parmi différentes modalités des informations médicalement associées ;
une plateforme de matrice de décision diagnostique (260, 724) dynamique configurée pour faciliter la génération d'une pluralité de matrices (230) d'informations diagnostiques en fusionnant différents types des informations médicalement associées et le résultat de l'analyse de celles-ci, dans laquelle la pluralité de matrices d'informations diagnostiques est organisée comme une hiérarchie et construite en fonction d'au moins un critère associé au patient, et dans laquelle des cellules dans les matrices comprennent des liens correspondant aux différentes sources à partir desquelles les informations diagnostiques sont extraites, et dans laquelle une première matrice à un premier niveau de la hiérarchie, laquelle est une matrice parente d'une seconde matrice à un second niveau dans la hiérarchie, comprend une quantité d'informations diagnostiques qui est inférieure à la quantité d'informations diagnostiques comprises dans la seconde matrice, et dans laquelle ladite fusion combine différents types d'informations médicalement associées de différents niveaux de hiérarchie selon le type de maladie et l'identification du patient,
un mécanisme de navigation d'informations diagnostiques (308) configuré pour faciliter la navigation parmi des informations diagnostiques représentées par la pluralité de matrices ;
un mécanisme de modification d'informations diagnostiques (314) qui peut être activé par un utilisateur pour la mise à jour des informations diagnostiques extraites, dans laquelle les matrices d'informations diagnostiques sont intégrées dans un outil interactif qui est activé pour la mise à jour de paramètres associés aux informations diagnostiques comprises dans les matrices ; et
un mécanisme de génération de rapport médical (255, 732) configuré pour produire un rapport médical signalant une décision médicale, dans lequel le rapport médical comprend un lien associant la décision diagnostique médicale à des informations diagnostiques représentées dans la pluralité de matrices.

7. Système selon la revendication 6, dans lequel l'extracteur d'informations diagnostiques comprend un analyseur de facteurs de risques particuliers à un patient configuré pour identifier les facteurs de risques particuliers à un patient basé sur les informations médicalement associées.

8. Support lisible par une machine ayant des instructions stockées sur celui-ci où les instructions, lorsqu'on y accède, permettent l'exécution de la méthode selon l'une quelconque des revendications 1 à 5.

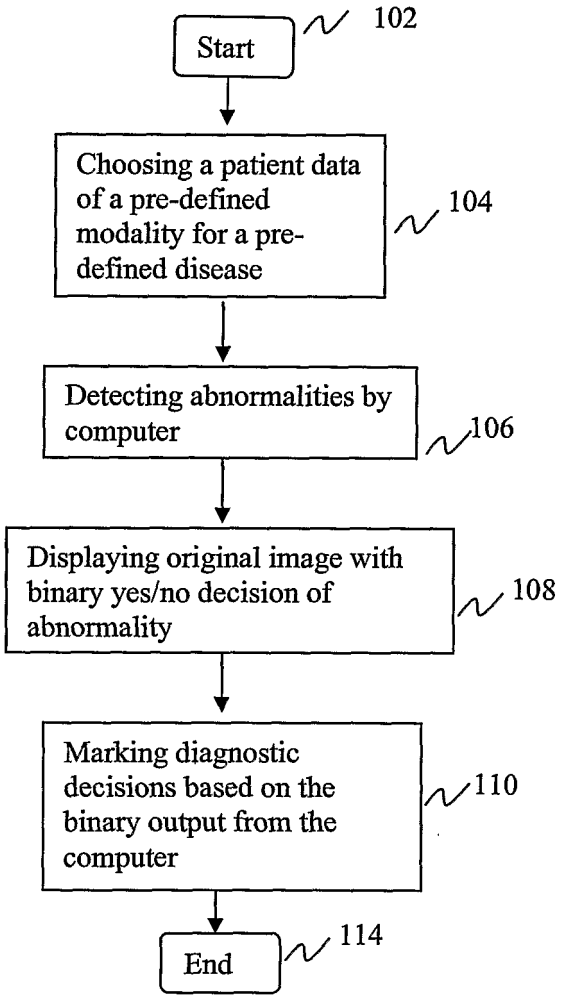

FIG. 1 (Prior art)

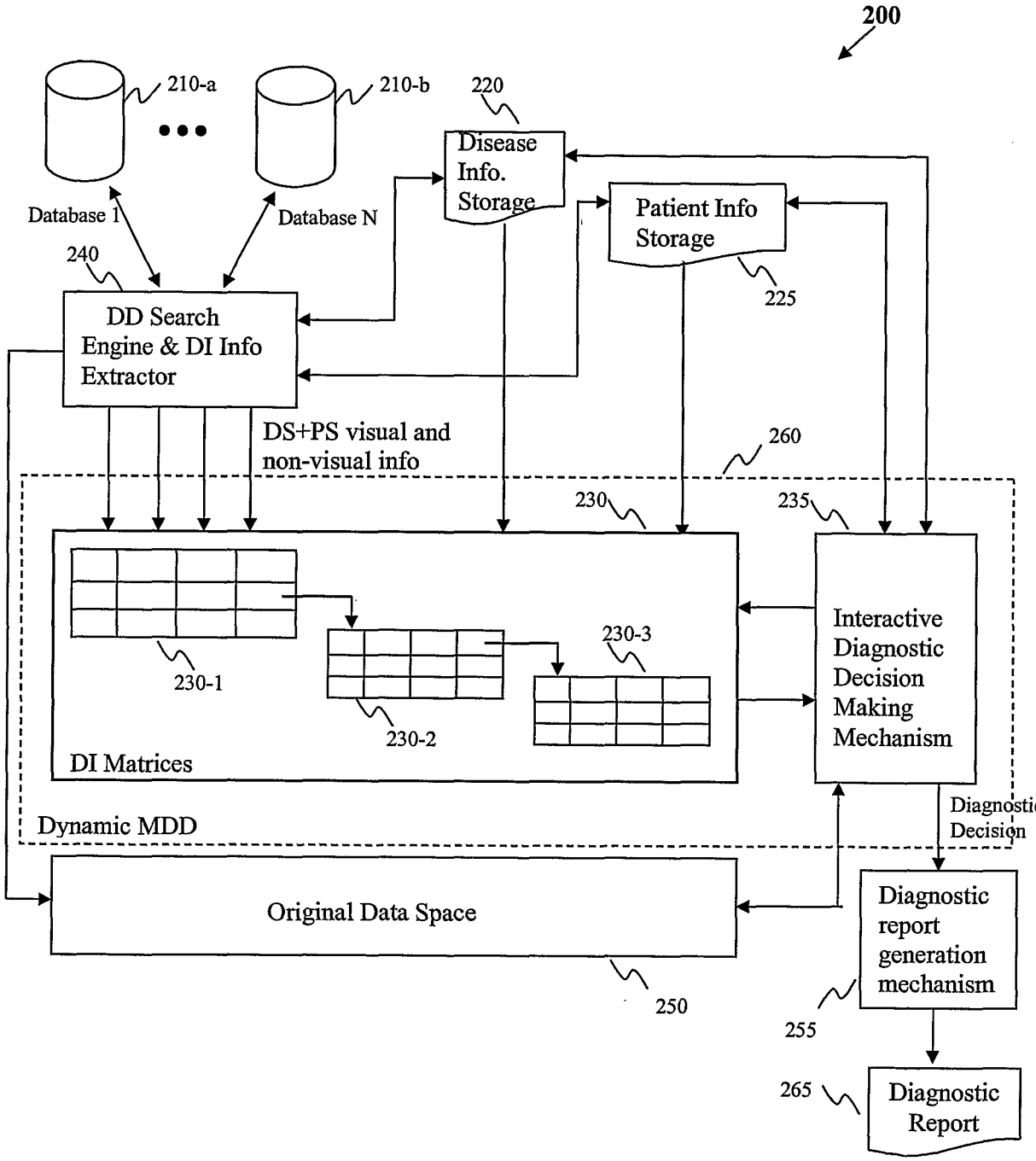
200
210-a
210-b
220
Disease Info. Storage
Database 1
Database N
Patient Info Storage
225
240
DD Search Engine & DI Info Extractor
DS+PS visual and non-visual info
260
230
235
230-1
230-2
230-3
DI Matrices
Interactive Diagnostic Decision Making Mechanism
Diagnostic Decision
Dynamic MDD
Original Data Space
250
Diagnostic report generation mechanism
255
265
Diagnostic Report

FIG. 2

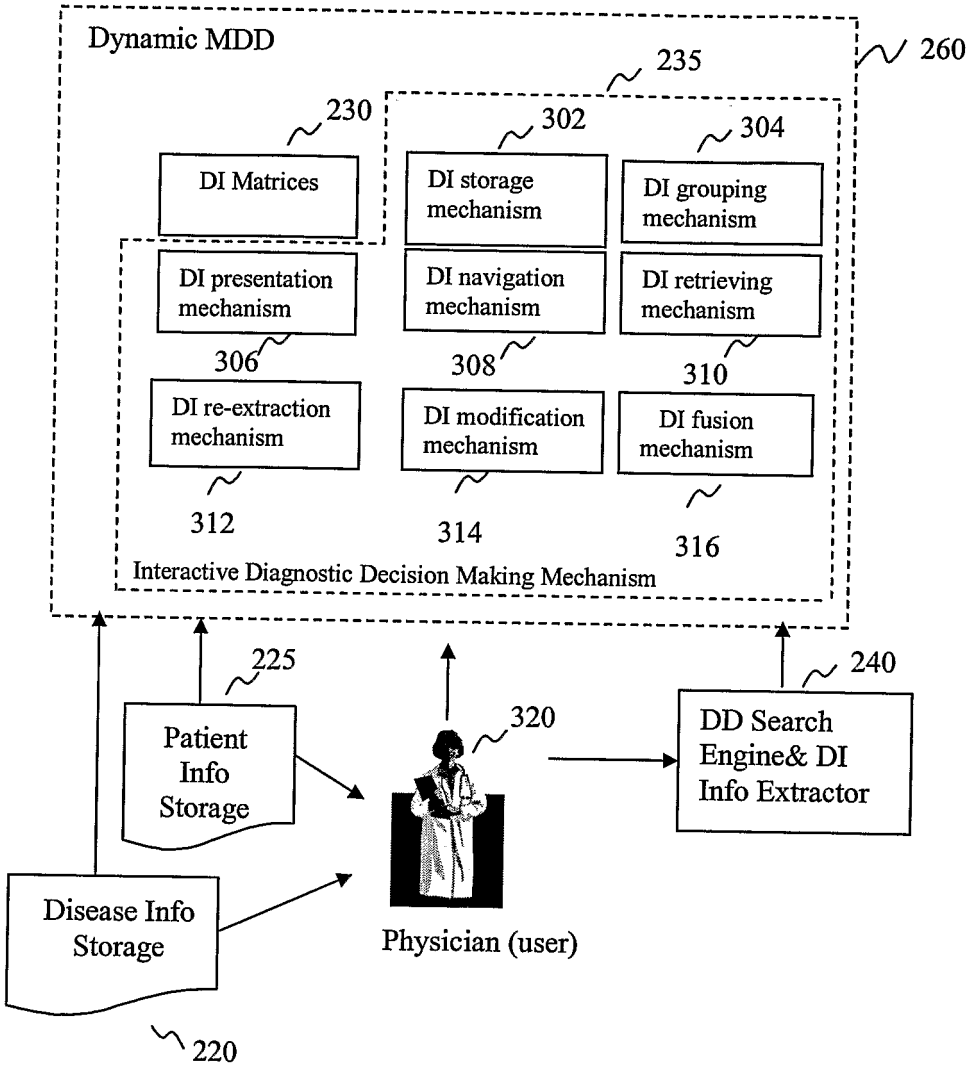
Dynamic MDD
260
235
230
302
304
DI Matrices
DI storage mechanism
DI grouping mechanism
DI presentation mechanism
DI navigation mechanism
DI retrieving mechanism
306
308
310
DI re-extraction mechanism
DI modification mechanism
DI fusion mechanism
312
314
316
Interactive Diagnostic Decision Making Mechanism
225
240
320
Patient Info Storage
DD Search Engine& DI Info Extractor
Disease Info Storage
Physician (user)
220

FIG. 3

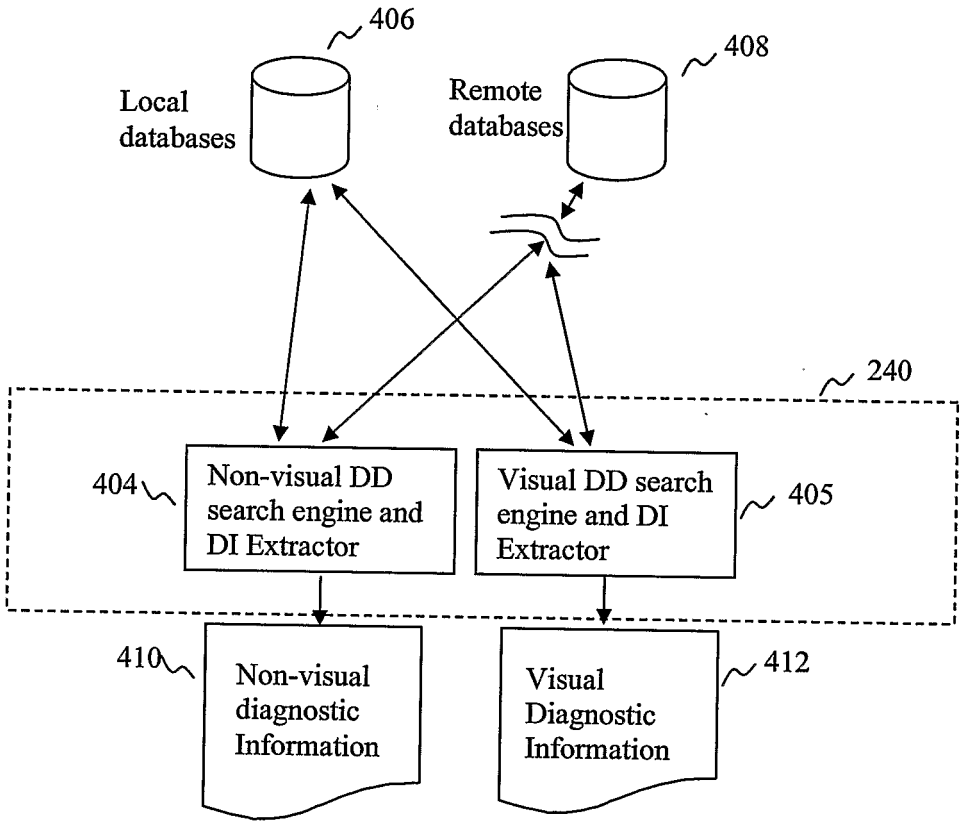
406
Local databases
408
Remote databases
240
404
Non-visual DD search engine and DI Extractor
Visual DD search engine and DI Extractor
405
410
Non-visual diagnostic Information
Visual Diagnostic Information
412

FIG. 4

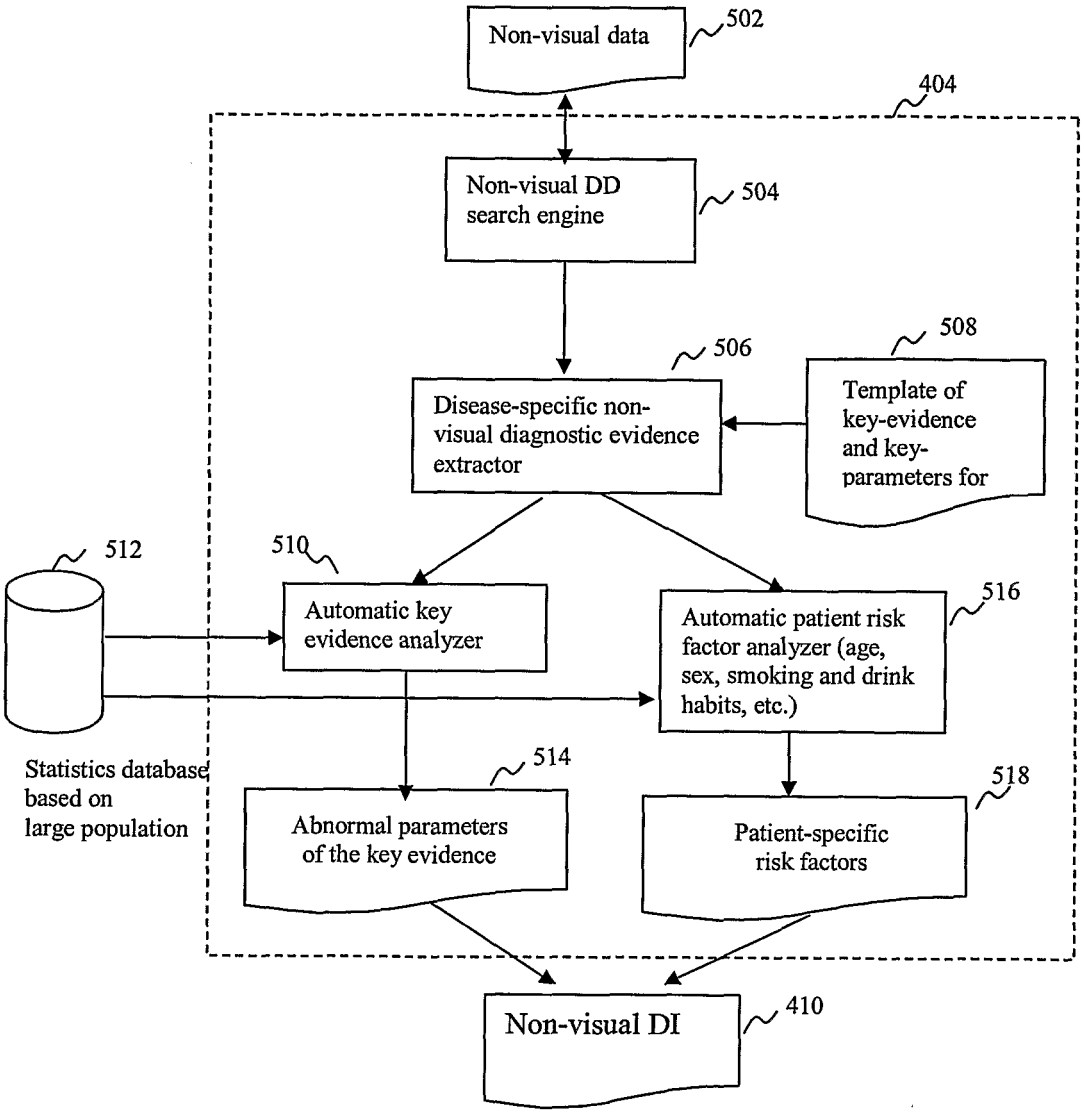
Non-visual data
502
404
Non-visual DD search engine
504
506
508
Disease-specific non-visual diagnostic evidence extractor
Template of key-evidence and key-parameters for
512
510
Automatic key evidence analyzer
516
Automatic patient risk factor analyzer (age, sex, smoking and drink habits, etc.)
Statistics database based on large population
514
Abnormal parameters of the key evidence
518
Patient-specific risk factors
Non-visual DI
410

FIG. 5

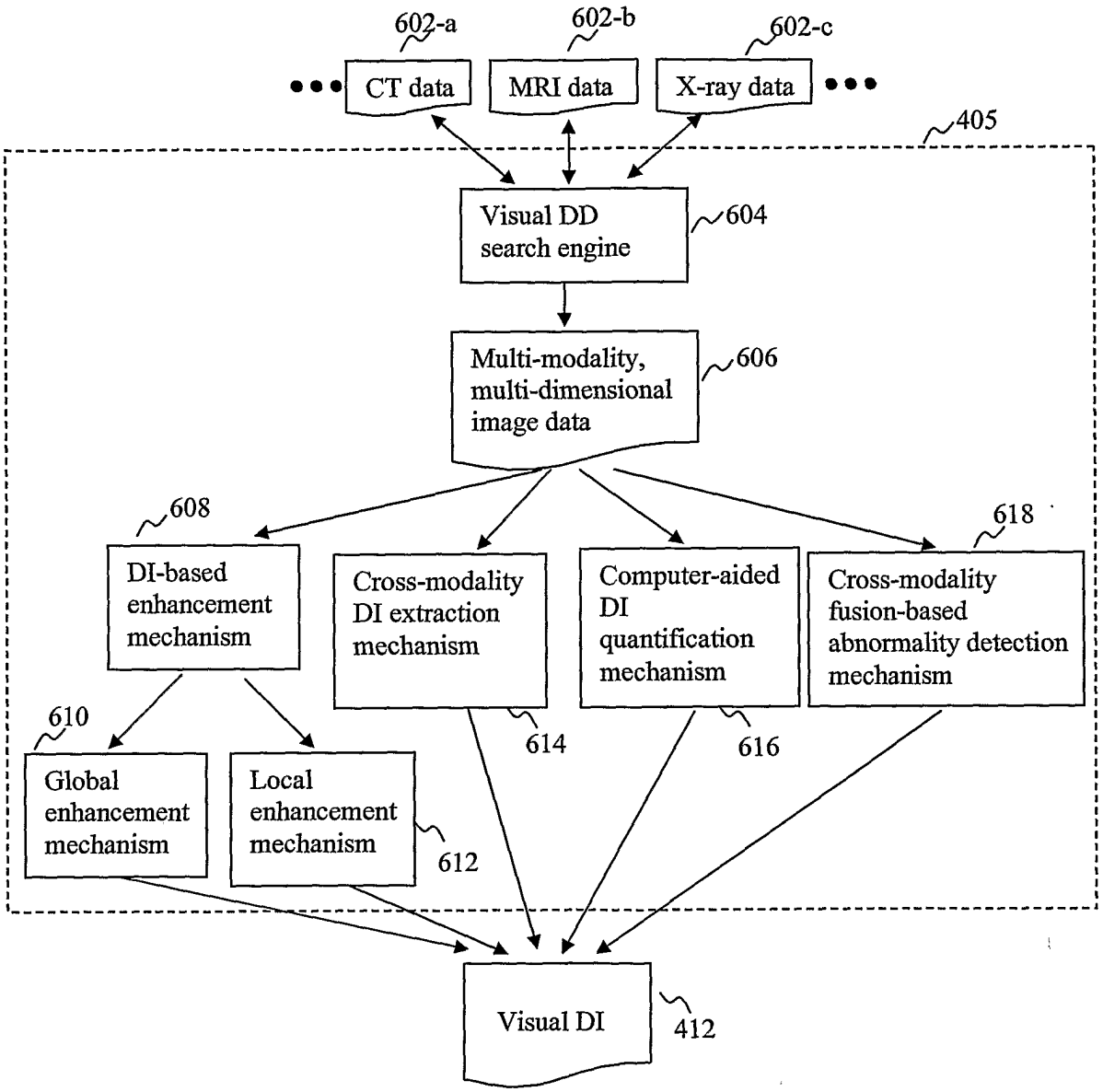
602-a
602-b
602-c
CT data
MRI data
X-ray data
405
Visual DD search engine
604
Multi-modality, multi-dimensional image data
606
608
618
DI-based enhancement mechanism
Cross-modality DI extraction mechanism
Computer-aided DI quantification mechanism
Cross-modality fusion-based abnormality detection mechanism
610
614
616
Global enhancement mechanism
Local enhancement mechanism
612
Visual DI
412

FIG. 6

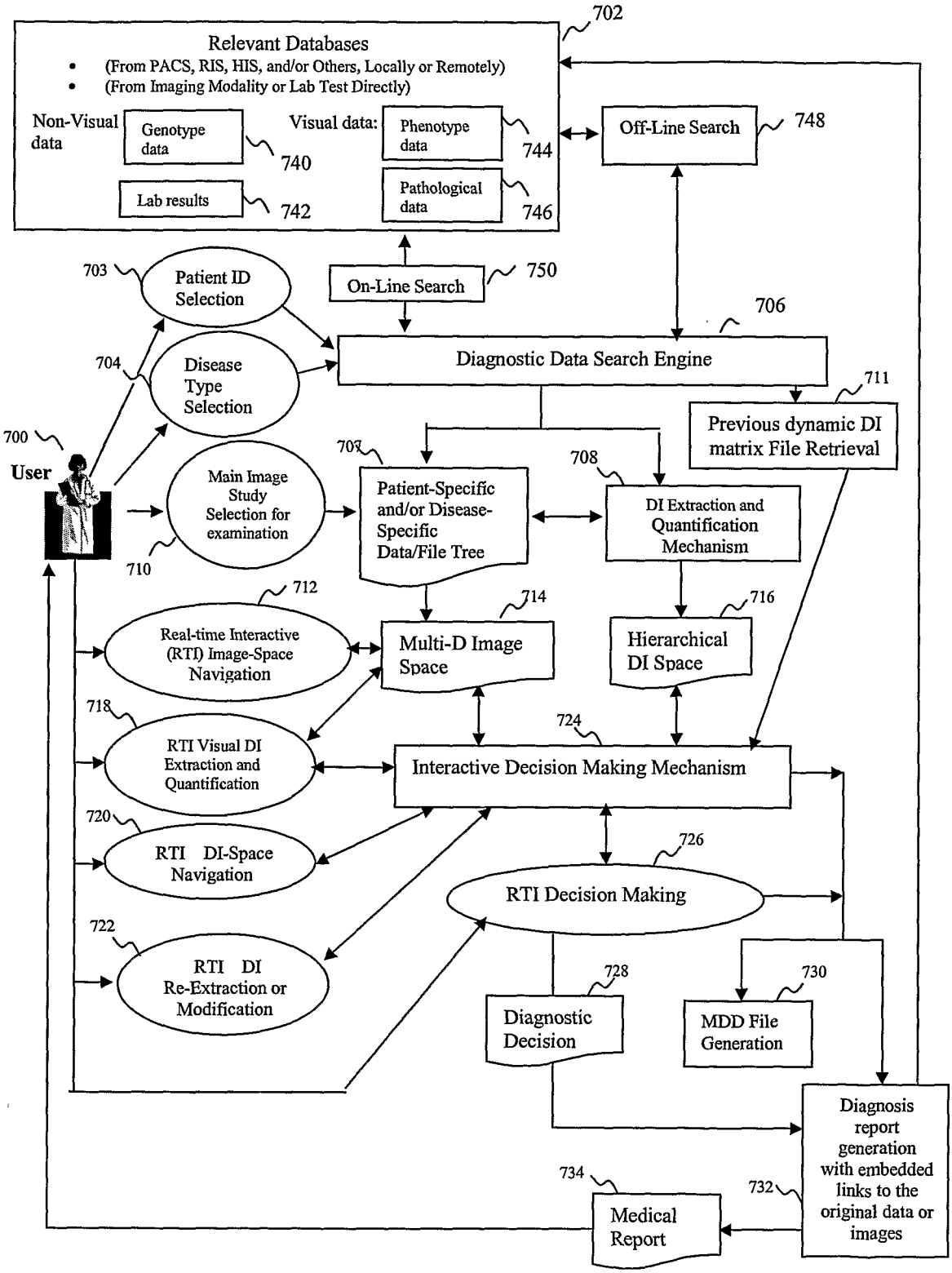
Relevant Databases
(From PACS, RIS, HIS, and/or Others, Locally or Remotely)
(From Imaging Modality or Lab Test Directly)
Non-Visual data
Genotype data
740
Lab results
742
Visual data:
Phenotype data
744
Pathological data
746
Off-Line Search
748
On-Line Search
750
702
703
Patient ID Selection
704
Disease Type Selection
706
Diagnostic Data Search Engine
711
Previous dynamic DI matrix File Retrieval
700
User
Main Image Study Selection for examination
710
707
Patient-Specific and/or Disease-Specific Data/File Tree
708
DI Extraction and Quantification Mechanism
712
Real-time Interactive (RTI) Image-Space Navigation
714
Multi-D Image Space
716
Hierarchical DI Space
718
RTI Visual DI Extraction and Quantification
724
Interactive Decision Making Mechanism
720
RTI DI-Space Navigation
726
RTI Decision Making
722
RTI DI Re-Extraction or Modification
728
Diagnostic Decision
730
MDD File Generation
Diagnosis report generation with embedded links to the original data or images
734
732
Medical Report

FIG. 7

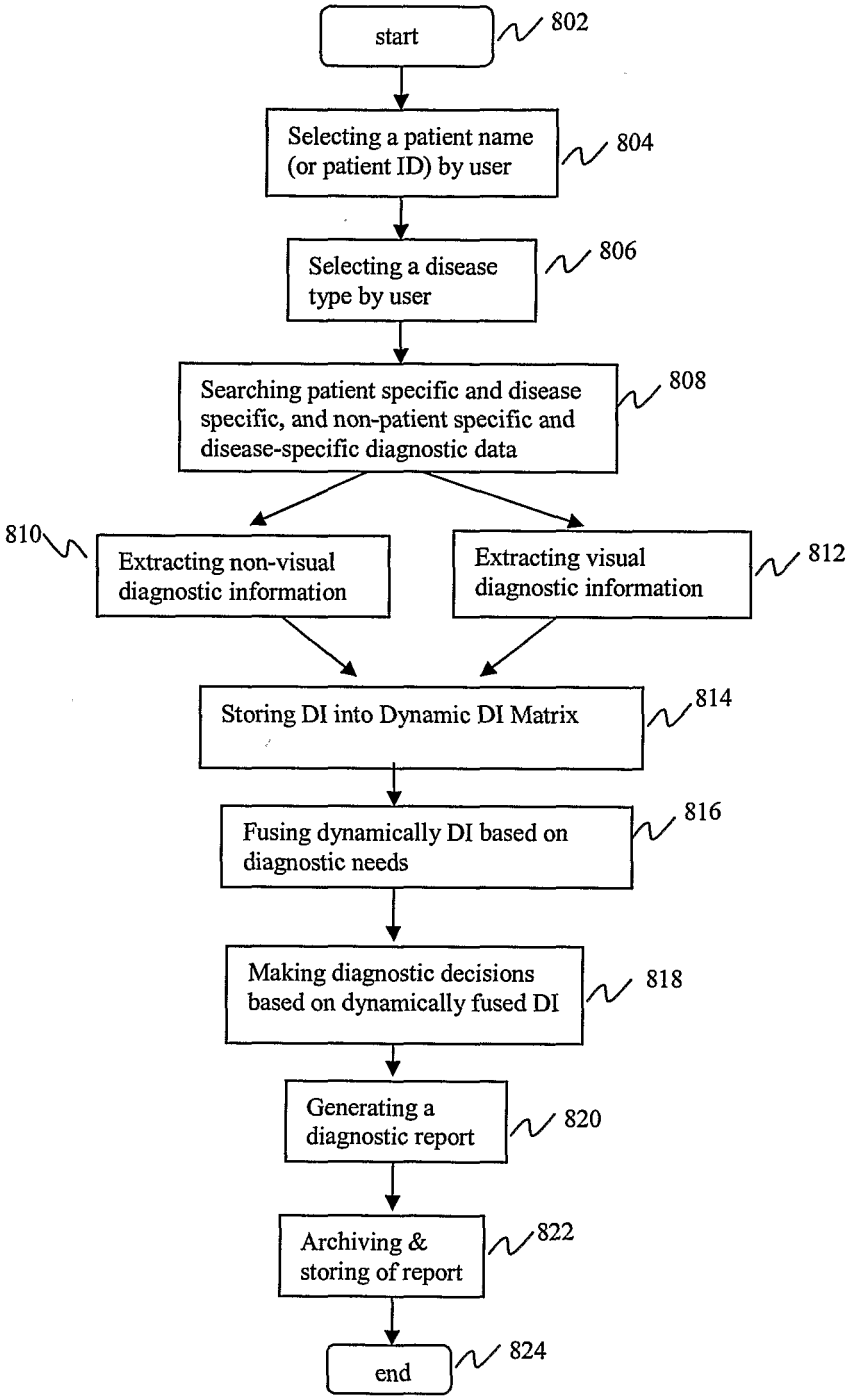
start
802
Selecting a patient name (or patient ID) by user
804
Selecting a disease type by user
806
Searching patient specific and disease specific, and non-patient specific and disease-specific diagnostic data
808
810
Extracting non-visual diagnostic information
Extracting visual diagnostic information
812
Storing DI into Dynamic DI Matrix
814
Fusing dynamically DI based on diagnostic needs
816
Making diagnostic decisions based on dynamically fused DI
818
Generating a diagnostic report
820
Archiving & storing of report
822
end
824

FIG. 8

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 49480203 P **[0001]**

Non-patent literature cited in the description

- **J.-Z. QIAN.** Intelligent Diagnostic Imaging and Analysis for Radiology. *FRONTIERS IN BIOMEDICAL ENGINEERING; 1ST ANNUAL WORDL CONGRESS OF CHINESE BIOMEDICAL ENGINEERS; WCCBME 2002,* 11 December 2002 **[0007]**
- Information Fusion for Automatic Lesion Detection in Diagnostic Image Analysis. *PRIS 2002 - PROCEEDIGNS OF THE 2ND INTERNATIONAL WORKSHOP ON PATTERN RECOGNITION IN INFORMATION SYSTEMS. IN CONJUNCTION WITH ICEIS 2002,* 01 April 2002, 33-44 **[0007]**

专利名称(译)	医学诊断智能定性和定量分析的方法和系统		
公开(公告)号	EP1654626B1	公开(公告)日	2019-07-31
申请号	EP2004781226	申请日	2004-08-13
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当前申请(专利权)人(译)	EDDA科技股份有限公司.		
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外部链接	Espacenet		

摘要(译)

公开了一种智能定性和定量分析（IQQA）系统和方法，其允许用户指定用于搜索和从不同来源获得医学相关信息的某些识别信息。医学相关信息可以是不同类型的，并且可以在需要时动态融合，以生成诊断信息的矩阵。可以基于这样的诊断信息矩阵来做出诸如诊断决定的医学决策。

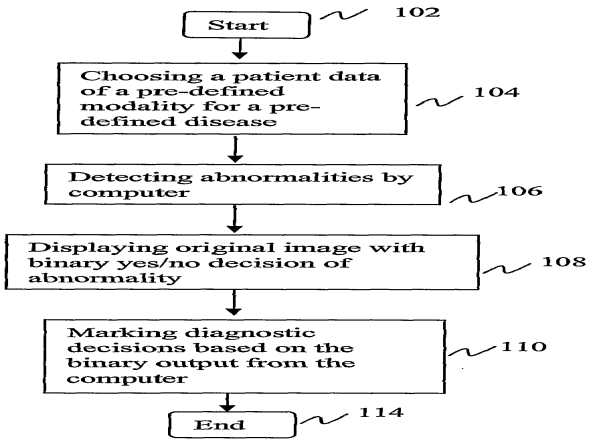

FIG. 1 (Prior art)