SYSTEM, METHOD AND COMPUTER INSTRUCTIONS FOR AIDING IMAGE ANALYSIS

Inventors: Mark M. Morita, Arlington Heights, IL (US); Prakash Mahesh, Schaumburg, IL (US)

Correspondence Address: MCANDREWS HELD & MALLOY, LTD 500 WEST MADISON STREET, SUITE 3400 CHICAGO, IL 60661

Assignee: General Electric Company

Publication Classification

Int. Cl. G06K 9/54 (2006.01)
U.S. Cl. 382/305

ABSTRACT

Certain embodiments of the present invention provide a system, method and computer instructions for aiding analysis of an image used in a medical examination. For example, in an embodiment, an image analysis system used in a medical examination comprises: an input module configured to input an image; a search module configured to locate information regarding an image that is similar to the input image; and an output module configured to output a link to the located information, wherein the located information is displayed when the link is used. For example, in an embodiment, an image analysis system used in a medical examination further comprises a communication module, wherein the communication module is configured to output the input image and the located information, and wherein the communication module is configured to receive a responsive communication.

200

Input image

202

Locate information regarding an image that is similar to the input image

204

Output link to located information

206

Communicate input image and located information / Receive a responsive communication

208

Input image analysis

210

Store image analysis

212
FIG. 2

Input image

Locate information regarding an image that is similar to the input image

Output link to located information

Communicate input image and located information / Receive a responsive communication

Input image analysis

Store image analysis
FIG. 3

300

Input Routine

302

Search Routine

304

Output Routine

306

Communication Routine

308

Analysis Input Routine

310

Storage Routine

312
SYSTEM, METHOD AND COMPUTER INSTRUCTIONS FOR AIDING IMAGE ANALYSIS

BACKGROUND OF THE INVENTION

[0001] The present invention generally relates to systems, methods and computer instructions for aiding image analysis. More particularly, the present invention relates to systems, methods and computer instructions for aiding image analysis by providing a link to information regarding an image that is similar to an image that is being analyzed.

[0002] Images can be used to aid in the monitoring and/or diagnosis of ailments. Such images are created using imaging systems. Two types of imaging techniques utilized by imaging systems are Computed Tomography (CT) imaging and/or Magnetic Resonance (MR) imaging, for example. Images collected using an imaging system are referred to collectively as an imaging study. Once an imaging study is completed, the images therein can be displayed on a workstation, such as a Picture Archiving and Communicating System (PACS) workstation, for example.

[0003] When an image is presented for review, a certain portion of the image can be considered interesting because, for example, that portion of the image could indicate abnormality. Abnormality in an image could indicate a certain disease, also known as, pathology. Thus, once abnormality is discovered, it is desirable to identify and diagnose the pathology that could be causing the abnormality.

[0004] People that review medical images, such as radiologists, for example, usually rely on past training and/or individual research in order to identify and diagnose pathology. Sometimes pathology is readily identified and diagnosed. However, when there is difficulty identifying and diagnosing unfamiliar pathology, time can be spent manually researching in order to identify and diagnose pathology. Further, mistakes can be made when identifying and diagnosing unfamiliar pathology.

[0005] There are systems that incorporate what is known as Computer Aided Diagnosis (CAD), which can aid in the identification of areas of interest in an image and mark such areas so that a user that is reviewing the image is alerted to the area. Further, systems that incorporate CAD can suggest pathology based on a comparison of the image to previously analyzed images. However, systems that incorporate CAD can provide false positives, that is, systems that incorporate CAD can falsely mark an area of an image as an area of interest when there is no pathology in that area of the image. Thus, although systems that incorporate CAD may be effective when pathology is readily identified and diagnosed, if there is difficulty identifying and diagnosing unfamiliar pathology, a person reviewing an image can still spend time manually researching in order to identify and diagnose pathology.

[0006] Thus, there is a need for a system, method and computer instructions for aiding image analysis that provides improved and/or streamlined identification and diagnosis of pathology in an image used in a medical examination.

BRIEF SUMMARY OF THE INVENTION

[0007] Certain embodiments of the present invention provide a system, method and computer instructions for aiding analysis of an image used in a medical examination. For example, in an embodiment, an image analysis system used in a medical examination comprises: an input module configured to input an image; a search module configured to locate information regarding an image that is similar to the input image; and an output module configured to output a link to the located information, wherein the located information is displayed when the link is used. For example, in an embodiment, an image analysis system used in a medical examination further comprises a communication module, wherein the communication module is configured to output the input image and the located information, and wherein the communication module is configured to receive a responsive communication.

[0008] For example, in an embodiment, a method for aiding analysis of an image used in a medical examination comprises: inputting an image; locating information regarding an image that is similar to the input image; and outputting a link to the located information, wherein the located information is displayed when the link is used. For example, in an embodiment, a method for aiding analysis of an image used in a medical examination further comprises: outputting the input image and located information; and receiving a responsive communication.

[0009] For example, in an embodiment, a computer-readable storage medium includes a set of computer instructions for aiding analysis of an image used in a medical examination, and the set of instructions comprises: an input routine that allows an image to be input; a search routine that allows information regarding an image that is similar to the input image to be located; and an output routine that allows a link to the located information to be output, wherein the located information is displayed when the link is used. For example, in an embodiment, a computer-readable storage medium includes a set of computer instructions for aiding analysis of an image used in a medical examination, and the set of instructions further comprises a communication routine, wherein the communication routine allows the input image and the located information to be output, and wherein the communication routine allows a responsive communication to be received.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 illustrates an image analysis system used in accordance with an embodiment of the present invention.

[0011] FIG. 2 illustrates a method for aiding analysis of an image used in accordance with an embodiment of the present invention.

[0012] FIG. 3 illustrates a set of computer instructions for aiding analysis of an image used in accordance with an embodiment of the present invention.

[0013] The foregoing summary, as well as the following detailed description of embodiments of the present invention, will be better understood when read in conjunction with the appended drawings. For the purpose of illustrating the invention, certain embodiments are shown in the drawings. It should be understood, however, that the present invention is not limited to the arrangements and instrumentality shown in the attached drawings.

DETAILED DESCRIPTION OF CERTAIN EMBODIMENTS

[0014] FIG. 1 illustrates an image analysis system used in accordance with an embodiment of the present
invention. The system 100 in FIG. 1 includes an input module 102, a search module 104, an output module 106, a communication module 108, an analysis input module 110 and a storage module 112.

[0015] In the system 100, the input module 102 is configured to input an image. The input module 102 can be configured to input many types of images. For example, in certain embodiments, the input module 102 can be configured to input an image created using Computed Tomography (CT) imaging and/or Magnetic Resonance (MR) imaging. Other ways to configure the input module 102 to input other types of images may exist, as known to those skilled in the art.

[0016] In the system 100, the input module 102 can be configured to input an image in many ways. For example, in certain embodiments, the input module 102 can be configured to input an image that is a selected portion of an image. In an example, a selected portion of an image can be a portion of the image that is suspected of showing pathology. In an example, a portion of an image that is suspected of showing pathology can be the entire image. In certain embodiments, the input module 102 can be configured to input an image that is a portion of an image that is selected by a user of an image review workstation. In an example, an image review workstation can be a Picture Archiving and Communicating System (PACS) workstation. In an example, a user of an image review workstation can include a radiologist, a technician or a cardiologist. In certain embodiments, the input module 102 can be configured to input an image that is a portion of an image that is selected by a system that incorporates Computer Aided Diagnosis (CAD). Other ways to configure the input module 102 to input images may exist, as known to those skilled in the art.

[0017] In the system 100, the input module 102 can be configured to input image information. The input module 102 can be configured to input many types of image information. For example, in certain embodiments, the input module 102 can be configured to input image information that includes: information regarding the type of imaging system that created the image, also known as, modality information; information regarding the body part that the image depicts; information regarding the contrast agent; and/or other Digital Imaging and Communications in Medicine (DICOM) header information. Other ways to configure the input module 102 to allow other types of image information to be input may exist, as known to those skilled in the art.

[0018] In the system 100, the input module 102 can be configured to input image information in many ways. For example, in certain embodiments, the input module 102 can be configured to input image information from: an imaging system; a database that is part of a Radiologist Information System (RIS); a database that is part of a Hospital Information System (HIS); a database that is accessible via the Internet; a local database; and/or any information source that is in networked communication with the input module 102. Other ways to configure the input module 102 to input image information may exist, as known to those skilled in the art.

[0019] In the system 100, the search module 104 is configured to locate information regarding an image that is similar to the input image. The search module 104 can be configured to locate information regarding an image that is similar to the input image in many ways. For example, in certain embodiments, the search module 104 can be configured to use an image recognition algorithm to identify images that are similar to the input image. For example, in certain embodiments, the search module 104 can be configured to restrict a search for an image that is similar to the input image based on information regarding the input image. In such embodiments, the search module 104 can be configured to restrict a search for an image that is similar to the input image based on modality information, body part information, contrast agent information and/or other DICOM header information, for example. Other ways to configure the search module 104 to locate information regarding an image that is similar to the input image may exist, as known to those skilled in the art.

[0020] In the system 100, the search module 104 can be configured to locate information in many ways. For example, in certain embodiments, the search module 104 can be configured to locate information that is accessible on a HIS, a RIS and/or the Internet. Other ways to configure the search module 104 to locate information in other places may exist, as known to those skilled in the art.

[0021] In the system 100, the search module 104 can be configured to locate information in many ways. For example, in certain embodiments, the search module 104 can be configured to locate a previous image analysis, an article, a report and/or a web page that includes an image similar to the input image. In an example, a previous image analysis can include an image(s), text and/or audio that include analysis and/or a conclusion/diagnosis. Other ways to configure the search module 104 to locate other types of information may exist, as known to those skilled in the art.

[0022] In the system 100, the output module 106 is configured to output a link to located information. The output module 106 can be configured to output a link to located information in many ways. For example, in an embodiment, the output module 106 can be configured to output a link as a visual display. In such an embodiment, the output module 106 can be configured to output a link to an image review workstation, such as a PACS workstation, for example. In such an embodiment, the link can link to information that is accessible on a HIS, a RIS and/or the Internet, and the information can be displayed when the link is used, for example. Other ways to configure the output module 106 to output a link to located information may exist, as known to those skilled in the art.

[0023] In the system 100, the communication module 108 is configured to output an input image and located information and receive a responsive communication. The communication module 108 can be configured to output an input image and located information and receive a responsive communication in many ways. For example, in an embodiment, the communication module 108 can be configured to output an input image and located information and receive a responsive communication via a collaboration system that allows patrons of the collaboration system to review the image and located information and provide a response. For example, in an embodiment, the communication module 108 can be configured to output an input image and located information and receive a responsive communication via a collaboration system that uses an instant messenger-like service or chat-room-like format to circulate an input image and located information and allow for a response to be provided, for example. Other ways to configure the communication module 108 to output the input image and the
located information and receive a responsive communication may exist, as known to those skilled in the art.

[0024] In the system 100, the analysis input module 110 is configured to input analysis information. The analysis input module 110 can be configured to input analysis information in many ways. For example, in an embodiment, the analysis input module 110 can be configured to input analysis information as an image(s), text and/or audio. For example, in an embodiment, analysis information can include: the input image as input and/or with markings on the image; other images that were included with the located information; typed or written text created by the user of the image review station; text that was included with the located information; audio created by the user of the image review station; and/or audio that was included with the located information. Other ways to configure the analysis input module 110 to input other types of analysis information may exist, as known to those skilled in the art.

[0025] In the system 100, the storage module 112 is configured to store analysis information. The storage module 112 can be configured to store analysis information in many ways. For example, in an embodiment, the storage module 112 can be configured to store analysis information in: a database that is part of a RIS; a database that is part of a HIS; a database that is accessible via the Internet; a local database; and/or any database that is in networked communication with the storage module 112. Other ways to configure the storage module 112 to store analysis information in other places may exist, as known to those skilled in the art.

[0026] The modules of the system 100 can be implemented in many ways. For example, the modules can be implemented in hardware and/or software. The modules can be implemented separately and/or integrated in various combinations. Other desirable ways to implement the modules of the system 100 may exist, as known to those skilled in the art.

[0027] The system 100 can also be implemented in many ways. For example, the system 100 can be integrated with existing applications that run on a Microsoft® platform and/or other platforms as an add-on product. In one implementation, the system 100 can be integrated with a workstation(s) that is connected to a HIS and/or a RIS, such as a PACS workstation, for example. Other desirable ways to implement the system 100 may exist, as known to those skilled in the art.

[0028] In operation, an embodiment of the system 100 can be implemented in connection with a HIS and/or RIS, for example. In such an embodiment, the input module 102 can be configured to input an image from an image review workstation such as a PACS workstation, for example. For example, an image of a spine can be input into the image review workstation. The user of the image review workstation can then identify an area of the image that may contain an abnormality. For example, the user of the image review workstation could identify an area of the image that contains a separation in the spine. The image could then be cropped to create a new image that is focused on the spine separation. The new image can be input into the input module 102. The search module 104 could then search images accessible on a HIS, a RIS and/or the Internet to locate an image(s) that is similar to the input image. In an embodiment, image information, such as, modality information, body part information, contrast agent information and/or other DICOM header information, can be also be input into the input module 102, and the search module 104 can restrict searches for images based on the image information. When an image that is similar to the input image is found, a link to the information regarding the located image can be output via the output module 106. For example, a link to a previous image analysis, an article, a report and/or a web page can be output as a visual display to an image review workstation, such as a PACS workstation, for example. In this example, where the input image includes a spine separation, links that could be output include: a link to a previous image analysis where a spine separation was diagnosed as a fracture; a link to a previous image analysis where a spine separation was diagnosed as a hairline fracture; a link to a previous image analysis where a spine separation was diagnosed as a rupture; a link to a report/article regarding Orthopedic Guidelines; a link to the web page www.ehealth.com; a link to a lab report for Calcium; a link to prior CT images; and/or a link to prior MR images, for example. After the links are output, a user of the image review station can review the information by selecting the links. If the user of the image review station is not ready to make a diagnosis, the communication module 108 can output the input image and the located information and receive a responsive communication via a collaboration system that uses an instant messenger-like service or chat-room-like format to circulate an input image and located information and allow for a response to be provided, for example. When the user of the image review station is ready to make a diagnosis, the user can input image analysis information into the analysis input module 110. For example, the user can input: the input image as input and/or with markings on the image; other images that were included with the located information; typed or written text created by the user of the image review station; text that was included with the located information; audio created by the user of the image review station; and/or audio that was included with the located information.

[0029] In operation, another embodiment of the system 100 can be implemented in connection with a HIS and/or RIS, for example. In such an embodiment, the input module 102 can be configured to input an image from a system that incorporates CAD. For example, an image of a kidney can be input into a system that incorporates CAD. The system that incorporates CAD can then identify an area of the image that may contain an abnormality. For example, the system that incorporates CAD could identify an area of the image that contains a mass on the kidney. The image could then be cropped to create a new image that is focused on the kidney.
mass. The new image can be input into the input module 102. The search module 104 could then search images accessible on a HIS, a RIS and/or the Internet to locate an image(s) that is similar to the input image. In an embodiment, image information, such as, modality information, body part information, contrast agent information and/or other DICOM header information, for example, can also be input into the input module 102, and the search module 104 can restrict searches for images based on the image information. When an image that is similar to the input image is found, a link to the information regarding the located image can be output via the output module 106. For example, a link to a previous image analysis, an article, a report and/or a web page can be output as a visual display to an image review workstation, such as a PACS workstation, for example. In this example, where the input image includes a kidney mass, links that could be output include: a link to a previous image analysis where a mass on a kidney was diagnosed as a tumor; a link to a previous image analysis where a mass on a kidney was diagnosed as a cyst; a link to a previous image analysis where a mass on a kidney was diagnosed as a malignant tumor; a link to a report/article regarding Sloan Kettering Guidelines; a link to a report/article regarding the American Cancer Society; a link to the web page www.mayo.com; a link to a lab report for Creatinine; a link to a lab report for Hematocrit; a link to a lab report for Glisson's Score; and/or a link to a lab report for pH Value, for example. After the links are output, a user of the image review station can review the information by selecting the links. Then the user can communicate with patrons of a collaboration system via the communication module 108 and/or input analysis information via the analysis input module 110 as described above with regard to the spine example. Once analysis information is input, the storage module 112 can store the analysis information as described above with regard to the spine example.

[0031] In operation, another embodiment of the system 100 can be implemented in connection with a HIS and/or a RIS, for example. In such an embodiment, the input module 102 can be configured to input an image from an image review station, such as a PACS workstation, for example, after the image has already been analyzed by a system that incorporates CAD. For example, an image of a breast can be input into the image review workstation from a system that incorporates CAD. The user of the image review workstation can review the image and decide whether the portion of the image that was identified by CAD as containing an abnormality, such as a lump, is the portion of the image that should be analyzed. If the user of the image review workstation agrees with the CAD analysis, the image could then be cropped to create a new image that is focused on the lump. If the user of the image review workstation does not agree with the CAD analysis, the user of the image review station can select a different portion of the image that the user believes contains an abnormality, such as a lump, and the image can be cropped to create a new image that is focused on the abnormality. The new image can be input into the input module 102. The search module 104 could then search images accessible on a HIS, a RIS and/or the Internet to locate an image(s) that is similar to the input image. In an embodiment, image information, such as, modality information, body part information, contrast agent information and/or other DICOM header information, for example, can also be input into the input module 102, and the search module 104 can restrict searches for images based on the image information. When an image that is similar to the input image is found, a link to the information regarding the located image can be output via the output module 106. For example, a link to a previous image analysis, an article, a report and/or a web page can be output as a visual display to an image review workstation, such as a PACS workstation, for example. In this example, where the input image includes a lump in a breast, links that could be output include: a link to a previous image analysis where a lump in a breast was diagnosed as a cyst; a link to a previous image analysis where a lump in a breast was diagnosed as a fibroid cyst; a link to a previous image analysis where a lump in a breast was diagnosed as scar tissue; a link to a report/article regarding Cysts; a link to a report/article regarding the JAMA; a link to the web page www.bCancer.com; and/or a link to the web page www.eMed.com, for example. After the links are output, a user of the image review station can review the information by selecting the links. Then the user can communicate with patrons of a collaboration system via the communication module 108 and/or input analysis information via the analysis input module 110 as described above with regard to the spine example. Once analysis information is input, the storage module 112 can store the analysis information as described above with regard to the spine example.
a HIS; a database that is accessible via the Internet; a local database; and/or any database that is in networked communication.

[0033] Due to the many types of pathology that exist, identifying and diagnosing pathology shown in an image used in a medical examination can be difficult and time consuming. Applying the method 200, as described above and/or in light of the description of FIG. 1, may provide improved and/or streamlined identification and diagnosis of pathology in images used in a medical examination.

[0034] FIG. 3 illustrates a set of computer instructions for aiding analysis of an image 300 used in accordance with an embodiment of the present invention. The set of computer instructions in FIG. 3 is configured to output a link to the located image when input routine 302, which allows an image to be input; a search routine 304, which allows information regarding an image that is similar to the input image to be located; an output routine 306, which allows a link to the located information to be output; a communication routine 308, which allows an input image and the located information to be output and a responsive communication to be received; an analysis input routine 310, which allows image analysis information to be input; and a storage routine 312, which allows image analysis information to be stored.

[0035] In certain embodiments, the input routine 302, the search routine 304, the output routine 306, the communication routine 308, the analysis input routine 310 and the storage routine 312 may be implemented and/or may perform functions similar to the input module 102, the search module 104, the output module 106, the communication module 308, the analysis input module 310 and the storage module 312, respectively, as described above in relation to FIG. 1.

[0036] While the invention has been described with reference to embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted without departing from the scope of the invention. In addition, many modifications may be made to adopt a particular situation or material to the teachings of the invention without departing from its scope. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed, but that the invention will include all embodiments falling within the scope of the appended claims.

1. An image analysis system used in a medical examination comprising:
   an input module configured to input an image;
   a search module configured to locate information regarding an image that is similar to the input image; and
   an output module configured to output the located information, wherein the located information is displayed when the link is used.

2. The system of claim 1, wherein the located information is accessible on at least one of: a Hospital Information System, a Radiologist Information System and the Internet.

3. The system of claim 1, wherein the located information is accessible on at least one of: a previous image analysis, an article, a report and a web page.

4. The system of claim 1, wherein the search module uses an image recognition algorithm to identify an image that is similar to the input image.

5. The system of claim 1, wherein the input module is configured to input image information including at least one of: modality information, body part information and contrast agent information, and wherein the search module is configured to restrict a search based on at least one of: modality information, body part information and contrast agent information.

6. The system of claim 1, further comprising a communication module, wherein the communication module is configured to output the input image and the located information, and wherein the communication module is configured to receive a responsive communication.

7. The system of claim 1, wherein the output module outputs the link as a visual display to a Picture Archiving and Communicating System workstation.

8. A method for aiding analysis of an image used in a medical examination comprising:
   inputting an image;
   locating information regarding an image that is similar to the input image; and
   outputting a link to the located information, wherein the located information is displayed when the link is used.

9. The method of claim 8, wherein the located information is accessible on at least one of: a Hospital Information System, a Radiologist Information System and the Internet.

10. The method of claim 8, wherein the located information is accessible on at least one of: a previous image analysis, an article, a report and a web page.

11. The method of claim 8, wherein locating information includes using an image recognition algorithm to identify an image that is similar to the input image.

12. The method of claim 8, further comprising inputting image information, wherein image information includes at least one of: modality information, body part information and contrast agent information, and wherein locating information includes restricting a search based on at least one of: modality information, body part information and contrast agent information.

13. The method of claim 8, further comprising:
   outputting the input image and located information; and
   receiving a responsive communication.

14. The method of claim 8, wherein the link is output as a visual display to a Picture Archiving and Communicating System workstation.

15. A computer-readable storage medium including a set of computer instructions for aiding analysis of an image used in a medical examination, the set of instructions comprising:
   an input routine that allows an image to be input;
   a search routine that allows information regarding an image that is similar to the input image to be located; and
   an output routine that allows a link to the located information to be output, wherein the located information is displayed when the link is used.

16. The set of computer instructions of claim 15, wherein the located information is accessible on at least one of: a Hospital Information System, a Radiologist Information System and the Internet.

17. The set of computer instructions of claim 15, wherein the located information is accessible on at least one of: a previously analyzed image, an article, a report and a web page.

18. The set of computer instructions of claim 15, wherein the search routine uses an image recognition algorithm to identify an image that is similar to the input image.

19. The set of computer instructions of claim 15, wherein the input routine allows image information to be input,
wherein image information includes at least one of: modality information, body part information and contrast agent information, and wherein the search routine allows a search to be restricted based on at least one of: modality information, body part information and contrast agent information.

20. The set of computer instructions of claim 15, further comprising a communication routine, wherein the communication routine allows the input image and the located information to be output, and wherein the communication routine allows a responsive communication to be received.

21. The set of computer instructions of claim 15, wherein the output routine allows the link to be output as a visual display to a Picture Archiving and Communicating System workstation.

* * * * *