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- (54) Title:** A METHOD FOR ANALYZING STROKE IN A PATIENT AT A MOBILE WORKSTATION

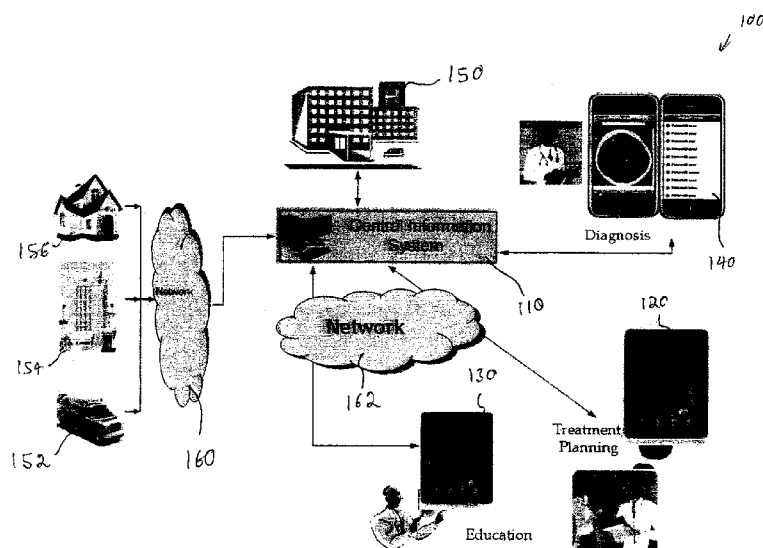


Figure 1

- (S7) Abstract:** A method for analyzing stroke in a patient at a mobile workstation. In a specific expression of the invention, the mobile workstation can download one or more 3-dimensional radiological datasets ("radiological volumes"), and simultaneously display multiple windows showing respective two-dimensional images which are slices of the radiological volume(s) perpendicular to respective "scrolling axes". The user can select such images from the radiological volume(s) by "scrolling through" the radiological volume(s) parallel to the scrolling axis. The selected images are analyzed, to generate a stroke assessment report, which is uploaded to a server. This permits stroke images to be analyzed quickly by an expert, irrespective of his or her location, and even if he or she is on the move.



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A Method for Analyzing Stroke in a Patient at a Mobile Workstation

Field of the Invention

The invention relates to a method for analyzing stroke in a patient at a mobile
5 workstation.

Background of the Invention

When a patient suffers from a stroke, in order to manage the stroke efficiently
and to provide the patient with good medical care, critical clinical data should be
10 made available to the clinicians as early as possible. This critical clinical data
takes the form of radiological images and multimedia data. The radiological
images and multimedia data typically are of very large sizes.

Software presently exists allowing for the analysis of radiological images and
15 the viewing of multimedia clinical data at a fixed workstation e.g. a PC or a
console of an imaging system. This software however lacks portability.

Summary of the Invention

The present invention aims to provide a new and useful method for analyzing
20 stroke in a patient, and a mobile workstation for carrying out the method.

The present invention is based on the novel concept that a mobile workstation
can download one or more 3-dimensional radiological datasets ("radiological
volumes"), and simultaneously display multiple windows showing respective

two-dimensional images which are slices of the radiological volume(s) perpendicular to respective "scrolling axes".. The user can select such images from the radiological volume(s) by "scrolling through" the radiological volume(s) parallel to the scrolling axis (that is, without changing the scrolling axis, 5 incrementally varying which slice perpendicular to the scrolling axis is displayed). The scrolling axis may be the axis along which the images are obtained (i.e. the "imaging axis") or may be an axis different from the imaging axis. The selected images are analyzed using software in the mobile workstation, to generate a stroke assessment report, which is uploaded to a 10 server.

This permits stroke images to be analyzed quickly by an expert, irrespective of his or her location, and even if he or she is on the move. It is indeed surprising that current mobile devices can implement such a critical procedure, and the 15 claims of the application are drawn to techniques which make this possible.

In general terms, a first expression of the invention proposes downloading at a mobile workstation at least part of a first radiological volume and at least part of a second radiological volume of a patient from a server. Respective images 20 from the downloaded first and second radiological volumes are displayed in the respective first and second user interface windows and inputs then are received from a user to modify which images of the radiological volumes are displayed.

Specifically, a first expression of the invention is a method for analyzing stroke in a patient at a mobile workstation, the mobile workstation being capable of displaying at least a first user interface window and a second user interface window, the method comprising the steps of

5 downloading at least part of a first radiological volume and at least part of a second radiological volume of the patient from a server, the first and the second radiological volumes each being a plurality of two-dimensional images of a region of the brain of the patient taken at spaced intervals along respective scrolling axes;

10 displaying respective images from the downloaded first and second radiological volumes in the respective first and second user interface windows;

 receiving inputs from a user of the workstation to modify which images of the radiological volumes are displayed, pairs of consecutively displayed images of a given one of the radiological volumes being nearest neighbours along the
15 respective scrolling axis, thereby selecting a said image of the first radiological volume and a said image of the second radiological volume;

 analyzing the respective selected images of the first and second radiological volumes by comparing the selected images to identify a part of the brain of the patient that is affected by stroke, said comparing including receiving
20 further inputs from the user;

 producing a stroke assessment report of the patient based on the identified part of the brain; and

 uploading the stroke assessment report onto the server.

A second expression of the invention proposes downloading at a mobile workstation at least part of a radiological volume of a patient from a server. The radiological volume is used to produce multiple 2-dimensional images showing slices of the radiological volume perpendicular to respective multiple scrolling
5 axes. The scrolling axes are mutually orthogonal (typically, they are axes in all three of the axial, coronal and sagittal directions). This allows for a stroke site to be viewed from multiple perspectives, thus resulting in a clearer understanding of the patient's condition. The images are displayed in the respective user interface windows, and inputs then are received from a user to modify which
10 images of the radiological volume are displayed.

Specifically, a second expression of the invention is a method for analyzing stroke in a patient at a mobile workstation, the mobile workstation being capable of displaying multiple user interface windows, the method comprising the steps
15 of

downloading at least part of a radiological volume of the patient from a server;
generating a plurality of images, the plurality of images showing
respective slices of the radiological volume perpendicular to respective scrolling
20 axes, the plurality scrolling axes being mutually orthogonal;
displaying the plurality of images in respective user interface windows;
receiving inputs from a user of the workstation to modify which images of
the radiological volume are generated and displayed, pairs of consecutively

displayed images for a given scrolling axis being nearest neighbours along that scrolling axis, thereby selecting images of the first radiological volume;

analysing the selected images to identify a part of the brain of the patient that is affected by stroke, said analysis including receiving further inputs from

5 the user;

producing a stroke assessment report of the patient based on the identified part of the brain; and

uploading the stroke assessment report onto the server.

10 One of the radiological volumes may be imaged by a technique selected from the group consisting of ultrasound, X-ray computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography (PET). The first and second radiological volumes may respectively be imaged by diffusion weighted imaging (DWI) and perfusion weighted imaging (PWI). Alternatively,
15 the first and second radiological volumes respectively are imaged by computed tomography (CT) and magnetic resonance imaging (MRI). Typically such data is captured as slices perpendicular to an imaging axis, and that imaging axis may be the scrolling axis referred to in the second expression of the invention.

Alternatively, the captured data may be re-expressed as a plurality of slices
20 perpendicular to a different scrolling axis, and this different scrolling axis may be the one employed in the second statement of the invention.

We now turn to features which are applicable to both expressions of the invention.

Preferably, the step of analyzing the selected images further comprises the step of

5 using the received further inputs to draw a region of interest on one of the selected images to indicate the identified part of the brain. This allows for attention to be drawn to a specific region of interest on the brain and thus information may be better conveyed in between clinicians or across different analysis sessions.

10 Preferably, the step of analyzing the selected images further comprises the step of

computing based on pixel information of the drawn region of interest a volume of the identified part of the brain indicated by the drawn region of interest. This allows the extent of a hemorrhage or infarction to be determined
15 quantitatively.

Preferably, the pixel information includes at least one of:

- a pixel count of the drawn region of interest;
- a maximum value of the pixels of the drawn region of interest;
- 20 a minimum value of the pixels of the drawn region of interest;
- a standard deviation of the values of the pixels of the drawn region of interest; and
- a mean of the values of the pixels of the drawn region of interest.

Preferably, the step of analyzing the selected images further comprises the step of processing the drawn region of interest with a segmentation technique selected from the group consisting of:

- thresholding;
- 5 merging anatomical structures;
- splitting at least one anatomical structure; and
- clustering anatomical structures.

This allows for the automatic delimiting of anatomical structures in the image of the brain.

10

Preferably, the step of analyzing the selected images further comprises the step of

 overlaying an atlas over one of the selected images in order to identify at least one anatomical landmark.

- 15 This allows for an easier analysis of the one of the selected images.

Preferably, the step of overlaying an atlas over one of the selected images further comprises the steps of, in the corresponding user interface window:

- identifying the anterior commissure (AC) and the posterior commissure
- 20 (PC) of the brain of the patient in the one of the selected images; and
- graphically drawing the atlas over the selected image relative to the identified AC and PC.

This allows for an optimal fitting of the atlas over the image.

Optionally, the step of overlaying an atlas over the selected image further comprises the steps of, in the corresponding user interface window:

using the received further inputs to adjust at least one bounding box on the selected image, the at least one bounding box demarcating a portion of the
5 brain; and

using the received further inputs to select further images from the radiological volume(s), the further image(s) respectively demarcating an inferior and a superior boundary of the brain.

10 Preferably, the step of analyzing the selected images further comprises the step of manipulating one of the selected images by performing an image adjustment using further user inputs, the image adjustment being one selected from the group consisting of:

panning of the one of the respective images;

15 zooming of the one of the respective images; and

window leveling of the one of the respective images.

This allows the image to be made clearer and allows for fine details to be seen and analyzed.

20 Preferably, the stroke assessment report further includes an assessment value computed using a stroke scale, the assessment value being indicative of a severity of the stroke. This allows for a systematic analysis of the severity of a stroke.

Preferably, the method further comprises the step of selecting the stroke scale from a plurality of stroke scales before producing the stroke assessment report. This allows for a variety of issues to be analyzed quantitatively.

5 Preferably, the method further comprises the step of switching one of the first and second user interface windows to a text interface to show computation of the assessment value using the stroke scale. This allows for the assessment value of the stroke scale to be computed while analyzing an image of a radiological volume and/or multimedia data.

10

Preferably, the method further comprises the step of switching one of the first and second user interface windows to an interface selected from the group consisting of a text interface, a video display interface, a three-dimensional display interface, and an image display interface.

15

A third expression of the invention is a mobile workstation for carrying out the methods defined above for analyzing stroke in a patient, the mobile workstation comprising

20

a screen capable of displaying the user interface windows,
a transceiver capable of downloading the radiological volume(s) of the patient from the server, the transceiver further being capable of uploading the stroke assessment report onto the server,
an input interface capable of receiving the inputs and the further inputs from the user, and

a processor containing software configured to carry out the method.

A fourth expression of the invention is a server programmed to enable a mobile workstation to carry out the methods defined above for analyzing stroke in a

5 patient, the server comprising

a transceiver configured to retrieve from another server a list of one or more clinician(s), the one or more clinician(s) each being associated with a corresponding one of a one or more mobile workstation(s); and

a processor containing software for carrying out the method for each of
10 the one or more mobile workstation(s), the software being configured to for each of the one or more mobile workstation(s):

upload via the transceiver the part(s) of the radiological volume(s) from the server to the mobile workstation by pushing the part(s) of the radiological volume(s), the part(s) of the radiological volume(s) being determined based on
15 a specialization of the associated clinician; and
download via the transceiver the stroke assessment report from the mobile workstation.

Such a server allows for the convenient broadcasting of parts of the radiological
20 volume(s) to one or more clinician(s). Also, information overload on the one or more clinician(s) is prevented as the radiological volume(s) are pushed selectively depending on a clinician's specialization.

Preferably, the software is further configured to for each of the one or more mobile workstation(s), process an image of the part(s) of the radiological volume(s) using an image processing algorithm. This thus alleviates the computation burden on the one or more mobile workstation(s).

5

Preferably, the software is further configured to for each of the one or more mobile workstation(s), record the time when the part(s) of the radiological volume(s) is uploaded to the mobile workstation, and record the time when the stroke assessment report is downloaded from the mobile workstation. This thus
10 allows for the time-stamping of data transactions between the mobile workstation and thus allows for ease of debugging.

A fifth expression of the invention is a method for diagnosing stroke in a patient at a mobile workstation, the mobile workstation being capable of displaying at
15 least two user interface windows, the method comprising the steps of
downloading at least part of a radiological data of the patient from a server;

displaying the downloaded radiological data in one of the at least two user interface windows, the one of the at least two user interface windows being
20 an interface selected from the group consisting of:

- a text interface,
- a video display interface,
- a three-dimensional display interface, and
- an image display interface;

analyzing the displayed radiological data to arrive at a stroke diagnosis;
producing a stroke assessment report of the patient based on the stroke
diagnosis; and
uploading the stroke assessment report onto the server.

5

Certain embodiments of the present invention may have the advantages of:

- providing clinicians with critical clinical data and tools to estimate stroke severity on a mobile workstation, thus resulting in better treatment planning and preparatory intervention on the move;
- 10 - facilitating treatment coordination between radiologists and clinicians of other specialties e.g. emergency room clinicians, surgeons and/or interventional neurologists;
- facilitating treatment coordination between specialist centers;
- allowing multiple clinicians to submit their reports on a patient
- 15 simultaneously;
- promoting parallel review by consolidating the opinions of multiple clinicians on a central server;
- being usable for education and research;
- being usable for the creation of teaching files and data bases;
- 20 - leveraging upon existing push technologies to make clinical data available to clinicians on the move;
- pooling software applications for stroke measurement, quantification, localization, stroke scale calculation, diagnosis, triage and preparing, and planning intervention into a single software suite;

- being usable for real-time analysis/interpretation of a stroke in a patient;
- allowing for computer aided diagnosis (CAD) of strokes;
- allowing for easy navigation between different viewing modes and configurations;
- allowing for clinicians to be contactable irrespective of their location;
- allowing for the multimedia viewing and editing of medical data;
- allowing more information to be conveyed than it is possible with a simple phone or video-call;
- allowing clinician to have a better understanding of the stroke case at hand;
- being secure such that patient information is kept private on the mobile workstation;

15 Brief Description of the Figures

By way of example only, one or more embodiments will be described with reference to the accompanying drawings, in which:

Figure 1 is a schematic drawing of a system for analyzing stroke in a patient according to an example embodiment;

20 Figure 2 is a flowchart of a method for analyzing stroke in the patient at a mobile workstation of the system of Figure 1;

Figure 3a is a screenshot of a user menu of software in the mobile workstation of the method of Figure 2.

Figure 3b is a screenshot of a table of content of an EMR View of the software of Figure 3a;

Figure 3c is a schematic drawing of a navigation hierarchy of the EMR View of Figure 3b;

5 Figures 4a is a screenshot of an Analysis View of the software of Figure 3b when operating as a "Dual Volume" view;

Figures 4b is a screenshot of the Analysis View of the software of Figure 3b when operating as a "Triplanar" view;

10 Figures 5 is a flowchart of optional sub-steps in an analysis step of the method of Figure 2;

Figure 6 is a flowchart of optional sub-steps in an atlas overlaying sub-step of Figure 5;

Figure 7a is a screenshot of the Analysis View of the software of Figure 3b when operating as a "Dual Window" view;

15 Figure 7b is another screenshot of the Analysis View of the software of Figure 3b when operating as a "Dual Window" view;

Figure 8a is a screenshot of a user interface window of the software of Figure 3b with pixel statistics overlaid;

20 Figure 8b is a screenshot of another user interface window of the software of Figure 3b where a plurality of bounding boxes are drawn;

Figure 9 is a schematic drawing of a navigation hierarchy for a plurality of stroke scales which are available for selection in the software of Figure 3b;

Figure 10 is a schematic drawing of a navigation hierarchy for a plurality of "Editing & Viewing tools" available in the software of Figure 3b;

Figure 11 is a schematic drawing of a navigation hierarchy for a plurality of view configurations available in the Analysis View of Figures 4a, 4b, 7a and 7b; and

Figure 12 is a schematic drawing of a flow of the software of Figure 3b as
5 experienced by a user.

Detailed Description of the Preferred Embodiment

Figure 1 shows a system 100 for analyzing stroke in a patient according to an example embodiment. The system 100 comprises a central information system
10 (CIS) 110 located in a hospital 150 and a plurality of mobile devices 120, 130 and 140 functioning as workstations. The mobile devices 120, 130 and 140 may be Apple iPhones, or Apple iPads, or may be Android-based devices such as a Samsung Galaxy Pad. Typically, such devices have integrated keyboards, or display keyboards on touch-sensitive screens, and are powered by integrated
15 battery supplies. The mobile devices 120, 130 and 140 communicate with the CIS 110 via a network 162. The network 162 may for example be a wireless Wi-Fi or 3G network. The network 162 may also be a wired network e.g. an Ethernet network.

20 The CIS 110 communicate with the Picture Archiving and Communication System (PACS) server (not shown) to retrieve and/or store three-dimensional radiological datasets and/or radiological images. In other words, the CIS 110 acts as a gatekeeper between the PACS and each of the mobile devices 120, 130 and 140. The CIS 110 monitors the data transactions between the mobile

devices 120, 130 and 140 and the PACS or other information servers, and is responsible for keeping a time recording of each of the data transactions.

The CIS 110 also retrieves from a Hospital Information System (HIS) server (not shown) a list of clinicians. Each clinician in the list is associated with one or more mobile devices. For each clinician in the list, the CIS 110 pushes a part of the radiological data to the associated one or more mobile devices. The part of the radiological data that is pushed is determined based on an attribute of the clinician, i.e. the name of the clinician, or the specialization of the clinician. As an example, should the clinician be identified as a radiologist, the whole of the radiological data is pushed to the associated one or more mobile devices. However, should the clinician be identified as a neurologist, only the part of the radiological data that is associated with the patient's brain is pushed to the associated one or more mobile devices. The use of the term "push" is understood to mean that the server has the onus of announcing the availability and facilitates the subsequent delivery of the radiological data to the mobile device(s).

Further, the CIS 110 is responsible for arranging the radiological data of each patient. For each patient, the CIS 110 creates a separate directory on the PACS for storing the radiological data (e.g. volumetric radiological data, or radiological images) and other information associated with the patient.

It is envisaged that the CIS 110 may be configured to have a computational power that is higher than each of the mobile devices 120, 130 and 140. Thus, the CIS 110 may be configured to perform image processing on one or more images that is contained in the radiological data of the patient. Additionally, the
5 higher computation power may allow the CIS 110 to evaluate the radiological data of the patient (e.g. to perform automatic diagnosis) or to perform an automated editing of the radiological data.

It is noted that the CIS 110 may take the form of a single server computer, or a
10 plurality of interconnected server computers. Additionally, it is envisaged that the CIS 110 may be hosted together with the PACS and HIS on the single server computer or the plurality of interconnected server computers.

The mobile devices 120, 130 and 140 are each configured to run software
15 capable of allowing a radiologist and/or clinician to analyze stroke that is present in a patient. The software is capable of retrieving three-dimensional radiological datasets (radiological volumes) of the patient from the CIS 110 and displaying radiological images from the datasets in at least two user interface windows. An analysis of the displayed radiological images, using the method
20 200 which is shown in Figure 2, is then carried out. The software is interactive in that it allows a user to visualize and work with multimedia data across a plurality of imaging techniques and view configurations. The system 100 thus forms an interactive stroke suite or "iStrokeSuite" for stroke management.

The system 100 also includes one or more image acquisition devices (not shown) which are responsible for collecting images from the patient. These devices may for example be CT or MRI machines and may capture images using a variety of different imaging techniques e.g. imaging using diffusion weighted imaging (DWI) or perfusion weighted imaging (PWI). The images are captured as a plurality of two-dimensional images (i.e. slices) at spaced intervals along an imaging axis of the patient. Collectively, the plurality of slices taken along an imaging axis would represent a radiological volume. The images captured are then stored onto the CIS 110.

10

The system 100 further includes workstations (not shown) communicating with the CIS 110 via another network 160. These workstations may either be mobile or fixed workstations and are located remote from the hospital 150, for example at a clinician's home 156, or at an offsite medical services center 154, or in an ambulance 152. The other network 160 is a network that permits remote access to the CIS 110 and may for example be the Internet, or a Virtual Private Network (VPN). By allowing access to the CIS 110 from remotely located workstations, the system 100 permits the offsite administering of medical care to stroke patients via telemedicine and further permits emergency medical care whilst the patient is in the ambulance 152 or whilst the clinician is at home 156.

20

While the system 100 is described with mobile devices 120, 130 and 140 used as workstations, it is understood the system 100 may additionally use computer

terminals (i.e. PC workstations) or use image acquisition and viewing devices (e.g. CT or MRI machines) as workstations.

Additionally, it is envisaged that the CIS 110 does not have to be located in the hospital 150 but may be located in a remote server location. In such a case, the CIS 110 may be configured to be accessible over the Internet.

Turning to Figure 2, Figure 2 shows a method 200 for analyzing stroke in a patient at a mobile workstation 120 of the system 100. The mobile workstation 120 has software configured to carrying out the method 200 with inputs received from the user.

In step 210, at least part of one or more (preferably, two or more) radiological volumes are downloaded from the CIS 110. The downloaded parts of the radiological volume(s) are each a plurality of 2D images captured by an image acquisition device at spaced intervals along a respective scrolling axis. The radiological volume(s) are of the brain of the patient. Note that the term "part" is used in this document to include the case that the whole of the radiological volume is downloaded.

20

Figure 3a shows a screenshot of a user menu of the software of the workstation 120. The user is allowed to access an electronic medical record (EMR) View by selecting the "EMR" option 305 from the user menu. Figure 3b shows a screenshot of a table of content (TOC) of the EMR View 310 of the software.

The TOC displays a plurality of EMRs of one or more patients in the form of a table. The TOC is populated with EMRs from a database and each of the EMRs is associated with data relating to a patient. This data comprises patient information and radiological images or videos associated with the patient. When
5 the user selects an EMR from the TOC of the EMR View 310, the workstation 120 carries out step 210 and downloads at least part of the radiological volume(s).

Additionally, the EMR View 310 allows the user to navigate into a plurality of
10 data viewing and analysis sub-modes. Figure 3c shows a navigation hierarchy of the EMR View 310. The user is permitted to navigate from the EMR View 310 to a Text-Case Sheet view 360, an Image Data View 370, a Multimedia View 380 or an Analysis View 390. The Text-Case Sheet view 360 permits the user to view a text-based case sheet of the patient while the Image Data View 370
15 permits images captured from the patient to be displayed. The Multimedia View 380 permits the display of multimedia data relating to the patient e.g. videos taken of a patient, or a voice narration recorded by a clinician attending to the patient, or any other audio. Finally, the Analysis View 390 permits the display and analysis of the parts of the radiological volume(s) which are downloaded in
20 step 210. It is noted that the user may choose to navigate from one view to another view at any time.

In step 220, images from the downloaded parts of the radiological volume(s) are displayed in corresponding user interface windows. This is carried out by the

software within the Analysis View 390. As discussed below, this may include generating new images, perpendicular to scrolling axes which are different from the imaging axes along which the data was captured.

5 Figures 4a and 4b are screenshots of the Analysis View 390 in different viewing modes. Figure 4a shows the Analysis View 390 configured as a "Dual Volume" view 391. In this configuration, which is useful when there are (at least) two radiological volumes, the screen of the workstation 120 is partitioned into first and second user interface windows 410 and 412. Each user interface window
10 for displaying images from a respective one of the two radiological volumes, either in an independent or synchronized fashion with the other user interface window. In the "Dual Volume" view 391, an image from the part of a first of the radiological volumes which was downloaded in step 210 is displayed in the first user interface window 410. An image from the downloaded part of the second
15 radiological volume is displayed in the second user interface window 412.

Figure 4b then shows the Analysis View 390 configured as a "Triplanar" view 392. In this configuration, the screen of the workstation 120 is partitioned into three user interface windows 420, 422 and 424. Images from the downloaded
20 part of one radiological volume are displayed in the user interface windows 420, 422 and 424. Specifically in the "Triplanar" view 392 shown in Figure 4b, the respective images of the user interface windows 420, 422 and 424 are images of the radiological volume from views respectively perpendicular to the axial, coronal and sagittal directions. In other words, a single radiological volume is

viewed from three perspectives. Since the radiological data will typically have been captured as slices perpendicular to a single imaging axis, this may require that the radiological volume is processed to re-express the data as slices perpendicular to other directions. In other words, the data is re-expressed as
5 slices along "scrolling" axes which allow the user to sequentially "scroll" through the slices along each "scrolling axis".

It is noted that the user may choose to navigate to and from the "Dual Volume" view 391 to the "Triplanar" view 392 at any time.

10

In step 230, inputs are received from a user of the workstation to modify which images of the radiological volume(s) are displayed. This is carried out within the Analysis View 390 by scrolling through the images of the radiological volumes along a scrolling axis. When the radiological volumes are scrolled in a direction
15 parallel to the scrolling axis), consecutively displayed images in a given user interface window are nearest neighbours along the respective scrolling axis. In other words, the images (or "slices") of the radiological volumes are displayed one after another ordered according to their sequence along the respective scrolling axis. By doing so, when the user stops scrolling through one of the
20 radiological volumes, he would have selected an image of the volume. The scrolling through a radiological volume may be accomplished using the wheel button of an attached mouse, or a scroll-bar 414 corresponding to each user interface window. It is noted that the scrolling axis may be the axis along which

the images are obtained (i.e. the “imaging axis”) or may be an axis different from the imaging axis.

Additionally, it is noted that in the case where each user interface window is
5 capable of displaying images from a radiological volume in a synchronized fashion with the other user interface window(s), by scrolling through the radiological volume of one of the user interface windows, the radiological volume(s) corresponding to the other user interface window(s) would also be scrolled through. Thus the images displayed in each of the user interface
10 windows would “evolve” through their respective radiological volumes and when the scrolling is stopped, the images displayed in each user interface window would be of the same anatomical region of the brain.

In step 240, the images selected in step 230 of the radiological volume(s) are
15 analyzed. This is done to identify a part of the brain of the patient that is affected by stroke.

Specifically, when the selected images are of different ones of the radiological volumes, the analysis may be a comparison of the selected images of the
20 respective volumes. Referring back to Figure 4a which shows the Analysis View 390 configured as a “Dual Volume” view 391, the radiological volumes corresponding to the first and second user interface windows 410 and 412 may be imaged using different techniques. As an example, the two radiological volumes of the “Dual Volume” view 391 may be imaged by computed

tomography (CT) and magnetic resonance imaging (MRI) respectively, or may be imaged by diffusion weighted imaging (DWI) and perfusion weighted imaging (PWI) respectively. In the former case where CT and MRI are used for imaging, the size of the hemorrhage or infarction may be observed from the images displayed in the first and second user interface windows 410 and 412 and thus compared. In the latter case where DWI and PWI are used, the core and penumbra of the infarction may be evaluated across the displayed images. From images of displayed in the first and second user interface windows 410 and 412, the mismatches in the DWI and PWI volumes, as well as location information about the infarction may be used by the clinician to decide on the course of treatment.

Further inputs also are received from the user in step 240. The received inputs allow the user to interact with the displayed images in optional sub-steps of step 240. These optional sub-steps 510 to 550 are shown in Figure 5. In other words, the user interacts with the displayed images using optional "Editing & Viewing tools". Figure 10 shows a navigation hierarchy with the "Editing & Viewing tools" available. The "ROI" tool is associated with sub-step 510, the "ROI – Stats" tool is associated with sub-steps 510 to 520, while the "Scroll", "Pan" and "Zoom" tools are associated with sub-step 540.

The optional sub-steps 510 to 550 of step 240 are described next with the aid of Figure 5. In optional sub-step 510, the received further inputs are used to draw a region of interest (ROI) on one of the selected images. This is done to indicate

an identified part of the brain. The ROI may be drawn either free hand, or in the form of geometrical shapes such as an ellipse, a circle, a square, or a rectangle. The ROI serves as a visual aid for future reference and may also be used to indicate a region of the brain which is afflicted with stroke.

5

Following from sub-step 510, sub-step 520 optionally may be performed to compute a volume of the identified part of the brain which is indicated by the drawn region of interest. This is performed using the pixel information within the drawn region of interest. These pixel information may be referred to as pixel statistics and includes the area of the drawn region of interest (i.e. the pixel count), as well as the maximum, minimum, standard deviation and mean of the values of the drawn region of interest. To obtain the volume, the area of the drawn region of interest is multiplied with the "thickness" of the selected image i.e. the distance between the selected image slice and an adjacent image slice, or the dimension of each voxel of the radiological volume.

15

After the volume of the identified part of the brain is computed, the volume is then scaled according to the spacing between consecutive pixels, as well as the "slice thickness" of the associated radiological volume i.e. the size of the intervals between pairs of consecutive images of the associated radiological volume. The radiological volume and the pixel statistics are then displayed overlaid on top of the image. This is illustrated in Figure 8a which shows a user interface window displaying an image of a radiological volume with pixel statistics overlaid.

20

Following from either of sub-steps 510 or 520, sub-step 530 may be performed to process the drawn region of interest with an image segmentation technique.

The image segmentation technique used may be one or more of image

- 5 thresholding, the merging or clustering of anatomical regions/structures, and/or the splitting of at least one anatomical region/structure. The image segmentation techniques are automatic. This step is useful for identifying the core and/or the infarction region, and thus permits a clinician to decide on the course of medical treatment.

10

Also optionally, the received further inputs may be used in sub-step 540 to manipulate one of the selected images by performing an image adjustment. The image adjustment may be one or more of a panning of the image, a zooming of the image, and/or the window leveling of the image. When panning the image,

15 the image is moved horizontally or vertically in the plane of display within the associated user interface so that only a portion of the image is displayed within the user interface. When zooming the image, the image is scaled by enlargement or shrinking resulting in a portion of the image being displayed within the user interface. When the image is window leveled, the brightness and

20 contrast of the image and/or the colour palette of the image is adjusted.

It is noted that window leveling is especially useful if the image is of 16-bit colour resolution. When window leveling is performed on such images, the dynamic range of each pixel is constrained and mapped to a smaller colour

range, e.g. an 8-bit range. The smaller colour range has greater contrast and thus allows features to become more easily visible. Additionally, the image is converted from a "continuous" mode (where each pixel is of 16-bit colour resolution) to a "discrete" mode (where there are less colours but with greater contrast between colours). The "discrete" mode selectively displays only the colours associated with certain anatomical structures present in the image. It is thus used to emphasize anatomical structures or a pathological condition. Examples of the "discrete" modes available are "skull" (where the skull is emphasized), "acute stroke" (where a stroke region is emphasized), "routine head" (which provides contrast between structures of the head), "soft tissue" (where soft tissue is emphasized), "full range" (where the image is shown with its full dynamic range), "subdural hematoma" (where the hematoma is emphasized) and "CT angio" (where the blood vessels are emphasized).

Further optionally, the step 240 may further comprise the sub-step 550 which overlays an atlas over one of the selected images i.e. the software enters an "Atlas Assisted" mode. This is done to label and/or identify one or more anatomical landmarks/structures in the image. The user enters the "Atlas Assisted" mode by clicking a button in the user interface. Atlas assisted analysis is advantageous as it allows a clinician to locate structures in a brain. This is especially true in the case where the radiological volumes are imaged using DWI and PWI. In this case, the radiological volumes are not morphological volumes and thus may contain distortions in the structures of the brain. The

identification of the structures of the brain which are affected by stroke is thus made difficult.

It is noted that without entering into the "Atlas Assisted" mode, the Analysis

- 5 View 390 of the software may be said to be in the "Normal" mode where analysis of the image is able to still take place but without the use of an atlas.

- Turning to Figure 6, Figure 6 shows the sub-steps 610 to 654 of the sub-step 550. In sub-step 610, the received further inputs of step 240 are used to adjust
- 10 at least one bounding box on the image, the at least one bounding box demarcating a portion of the brain. The image contains the anterior commissure (AC) and the posterior commissure (PC) of the brain i.e. the image is an AC-PC slice. This is illustrated in Figure 8b where a user interface window is shown displaying an AC-PC slice with a plurality of bounding boxes drawn to
- 15 demarcate an anterior 850, a posterior 852, a left 854 and a right 856 portions of the brain, as well as a mid-sagittal plane 858.

In sub-step 620, the AC and the PC of the brain of the patient are identified in the image.

20

In sub-step 630, a first and a second image from the plurality of images of the corresponding radiological volume are selected. The first and second images respectively serve to demarcate an inferior and a superior boundary of the brain.

In sub-step 640, the atlas is drawn graphically over the image relative to the identified AC and PC i.e. the AC and PC are used as landmarks in the registration of the atlas with the image. The atlas is thus said to be “wrapped”
5 around or onto structures in the radiological volume using the boundaries defined in sub-steps 610 and 630; by demarcating the anterior 850, posterior 852, left 854 and right 856 portions of the brain, the mid-sagittal plane 858 and the inferior and superior boundaries of the brain, the boundaries for the graphical rendering of the atlas are defined. It is noted that any linear or non-
10 linear registration technique may be used and any other structure of the brain (other than the AC and PC) may be used for registration.

It is noted that sub-steps 610 and 630 are not essential for the operation of sub-steps 620 and 640 i.e. sub-steps 620 and 640 may be performed automatically
15 without the need for the sub-steps 610 and 630. Additionally, sub-steps 610 to 640 may also be optional in which case in sub-step 550, the atlas may be overlaid over the image either manually by the user, or it may be overlaid automatically using a different algorithm that is known in the art.

20 The following steps 650 to 654 are then optionally performed. In sub-step 650, the transparency of the atlas that is drawn over the image is adjusted. In sub-step 652, the atlas that is drawn is automatically labeled with the name of anatomical structures and landmarks. In sub-step 654, the user chooses to

switch the atlas to another atlas. As an example, in sub-step 654, the user chooses to switch from an anatomical atlas to a blood supply atlas.

Returning to Figure 2, in step 250, a stroke assessment report of the patient is produced. The stroke assessment report takes the form of a text file and may contain one or more observations which are entered into software.

The stroke assessment report optionally may contain an assessment value that is computed using a stroke scale. This assessment value is indicative of a severity of the stroke. Visual observations from the displayed radiological images may also be used as input parameters for the stroke scale. Examples of such stroke scales which take into account visual observations are: the National Institutes of Health Stroke Scale (NIHSS) - which takes into account a patient's motor function, the HAS-BLED score, and the CHA2DS2-VASc score – which may be used to analyze the infarcted area with respect to the middle cerebral artery (MCA) for the purpose of thrombolysis.

Where a stroke scale is used to compute an assessment value, the Analysis View 390 of the software is configured to display the computation of the assessment value in a text interface. Figures 7a and 7b are screenshots of the Analysis View 390 in a "Dual Window" view 393 configuration. In this configuration, one of the first or second user interface windows 410 and 412 displays information of a mode different from the images of the radiological volumes which are displayed in the "Dual Volume" view 392. When a stroke

scale is used to compute an assessment value, the "Dual Window" view 393 is used to display a text interface showing the computation of the assessment value. This text interface is editable so as to allow corrections to be made to the computation of the assessment value.

5

The screenshot of Figure 7a shows an example where the first user interface window 410 shows an image from an associated radiological volume while the second user interface window 420 shows a text interface showing the computation of the assessment value using a stroke scale. As a further

10 example, in the screenshot of Figure 7b, the first user interface window 410 shows a video that is accompanied by an audio recording while the second user interface window 420 shows a text interface showing the computation of the assessment value using another stroke scale.

15 Additionally, it is envisaged that the first and second user interface windows 410 and 420 may respectively show the computation of a first and second assessment values using a respective first and second stroke scales. In such a configuration, the computation of two assessment values using two stroke scales may be compared side by side. Thus, the outcome of a patient according
20 to two different stroke scales may be analyzed, or the outcome of two different patients according to a common stroke scale may also be analyzed.

The alternative configuration of the "Dual Volume" view 391 is advantageous because it allows for the evaluation of the condition of the patient whilst

- evaluating and/or update the stroke scale. The user of the workstation 120 is thus capable of comparing at the workstation 120 different data sets whilst correcting the stroke scale (if necessary). Additionally, since the first user interface window 410 is also capable of displaying multimedia information other than images from a radiological volume, the user thus is able to evaluate and/or update the stroke scale more accurately with more information at hand. It is also envisaged that the user may evaluate and/or update the stroke scale whilst physically inspecting the patient.
- 10 Optionally, the stroke scale that is used to compute the assessment value may be selected in step 250 from a list of stroke scales before the stroke assessment report is produced. Figure 9 shows a navigation hierarchy with the stroke scales which are available for selection. The stroke scales that may be selected are:
- 15 prehospital stroke scales;
 acute assessment scales;
 functional assessment scales;
 outcome assessment scales;
 stroke stratification scales;
- 20 other diagnostic and screen tests; and
 rehabilitation and nursing scales.

In step 260, the stroke assessment report produced in step 250 is uploaded onto the CIS 110. Should the stroke assessment report also contain an

assessment value computed according to a stroke scale, the assessment value and its computation is updated into the EMR of the patient. This allows the assessment value and its computation to be retrieved for editing, or to be used in other follow-up procedures.

5

Further, should one or more ROIs be drawn in the optional sub-step 510, data encoding the ROIs also uploaded into the CIS 110. This allows the ROIs to be visible when the radiological volumes are downloaded in a different session.

- 10 It is envisaged that the method 200 may further also comprise after step 220, a step of saving an image from one of the two or more radiological volumes into a local storage. This step if performed after step 240 may contain the ROIs drawn (if any) encoded within the saved image. The saved images are stored in a local folder which has built-in privacy features. This reduces any privacy risks in the
- 15 saved images being inadvertently leaked.

- In relation to the sub-step 550, it is noted that the atlas that is overlaid may either be three-dimensional or two-dimensional. The atlas may also for example be a TT88 atlas, or it may be a blood supply atlas. The atlas may have a
- 20 controllable transparency which prevents the atlas from occluding the image underneath it. As an example, the atlas may be a perfusion map of an existing stroke and by overlaying the atlas over the image with an amount of transparency, the penumbra regions of two different stroke occurrences may be compared. Additionally, more than one atlases may be overlaid in sub-step 550.

Turning now to Figure 11, the view configurations available in the Analysis View 390 is described next. Like numerals are used to refer to elements which have been described previously.

5

When in the Analysis View 390, the user is allowed to switch to a "Triplanar" view 392 (which is illustrated in Figures 4b), a "Dual Volume" view 391 (which is illustrated in Figure 4a), or a "Dual Window" view 393 (which is illustrated in Figures 7a and 7b).

10

In the "Triplanar" view 392, three user interface windows 420, 422 and 424 are available and they respectively display images of a radiological volume from respective views across an axial, a coronal and a sagittal planes.

15 In the "Dual Volume" view 391, two user interface windows 410 and 412 are available and they display respective images from a first and a second radiological volumes. The first and the second radiological volumes may be imaged using a DWI and PWI, or using CT and MRI, or using any other combination of imaging techniques.

20

In the "Dual Window" view 393, two user interface windows are available and the user interface windows may be configured to display, image data in the first user interface window and text data in the second user interface window, or video data in the first user interface window and text data in the second user

interface window, or text data in the first user interface window and text data in the second user interface window.

In all the view configurations, "Editing & Viewing Tools" (as illustrated in the navigation hierarchy of Figure 10) are available for use by the user.

An example of the flow of the software as experienced by a user is described next with the aid of Figure 12. The steps of the method 200 are denoted in Figure 12 using like reference numerals.

10

In 1210, the user starts using the software. In 1212, the user enters the EMR View 310 by selecting the "EMR" option 305 from a user menu of the software. The user then selects an EMR and the software downloads at least part of two or more radiological volumes from the CIS 110.

15

In 1220, the software is ready to display images from the at least part of the two or more radiological volumes. The software enters the Analysis View 390 and the user may choose to view the downloaded radiological volumes in a "Triplanar" view 392 as illustrated in Figures 4b, in a "Dual Volume" view 391 as illustrated in Figure 4a, or in a "Dual Volume" view as illustrated in Figures 7a or 7b. In 1222, the "Editing & Viewing tools" as shown in the navigation hierarchy of Figure 10 are available for selection.

20

In 1230, the user modify which images of the at least part of the two or more radiological volumes are displayed in order to select an image of each of the two or more radiological volumes.

- 5 In 1240, the user is given an option to enter into "Atlas Assisted" mode in 1242 or remain in the "Normal" mode in 1241. Should the user choose to enter into the "Atlas Assisted" mode in 1242, an atlas is overlaid or "wrapped" onto one of the selected images in 1243.
- 10 In 1244, the user once again may choose to view the images of the two or more radiological volumes in a "Triplanar" view 392, in a "Dual Volume" view 391, or in a "Dual Window" view. In 1245, the "Editing & Viewing tools" as shown in the navigation hierarchy of Figure 10 are once again available for selection.
- 15 In 1246, the user selects a stroke scale from a list in anticipation of producing a stroke assessment report. In 1247, one or more of the "Editing & Viewing tools" as shown in the navigation hierarchy of Figure 10 are used.

- In 1250, the stroke assessment report is produced and in 1260, the report is
- 20 uploaded onto the CIS 110.

In an embodiment of the present invention, it is envisaged that the software and mobile workstation 120 may be configured to be usable offline. In such a case,

the mobile workstation 120 and software is usable as a research and teaching tool.

In another embodiment of the present invention, it is envisaged that the mobile workstation 120 may download data from the CIS 110 via a first mode of communication while upload data to the CIS 110 via a second mode of communication. The first mode of communication may be configured to be of a “push” mechanism, e.g. an SMS with a link for automatic download, or a formatted email containing such a similar link. The second mode of communication may be an Internet connection, or a Wi-Fi or 3G data connection.

Whilst example embodiments of the invention have been described in detail, many variations are possible within the scope of the invention as will be clear to a skilled reader. For example, whilst the use of different imaging techniques is described in step 240 in relation to the “Dual Volume” view 391 configuration of the Analysis View 390, it is understood that the use of different imaging techniques can also be used in the “Triplanar” view 392 configuration.

Claims

1. A method for analyzing stroke in a patient at a mobile workstation, the mobile workstation being capable of displaying at least a first user interface window and a second user interface window, the method comprising the steps of
- 5 of
- downloading at least part of a first radiological volume and at least part of a second radiological volume of the patient from a server, the first and the second radiological volumes each being a plurality of two-dimensional images
- 10 of a region of the brain of the patient taken at spaced intervals along respective scrolling axes;
- displaying respective images from the downloaded first and second radiological volumes in the respective first and second user interface windows;
- receiving inputs from a user of the workstation to modify which images of
- 15 the radiological volumes are displayed, pairs of consecutively displayed images of a given one of the radiological volumes being nearest neighbours along the respective scrolling axis, thereby selecting a said image of the first radiological volume and a said image of the second radiological volume;
- analyzing the respective selected images of the first and second
- 20 radiological volumes by comparing the selected images to identify a part of the brain of the patient that is affected by stroke, said comparing including receiving further inputs from the user;
- producing a stroke assessment report of the patient based on the identified part of the brain; and

uploading the stroke assessment report onto the server.

2. The method according to claim 1 wherein one of the radiological volumes is imaged by a technique selected from the group consisting of:

- 5 ultrasound;
 X-ray computed tomography (CT);
 magnetic resonance imaging (MRI); and
 positron emission tomography (PET).

10 3. The method according to claim 1 wherein the first and second radiological volumes respectively are imaged by diffusion weighted imaging (DWI) and perfusion weighted imaging (PWI).

4. The method according to claim 1 wherein the first and second
15 radiological volumes respectively are imaged by computed tomography (CT) and magnetic resonance imaging (MRI).

5. A method for analyzing stroke in a patient at a mobile workstation, the mobile workstation being capable of displaying multiple user interface windows,
20 the method comprising the steps of
 downloading at least part of a radiological volume of the patient from a
server;

generating a plurality of images, the plurality of images showing respective slices of the radiological volume perpendicular to respective scrolling axes, the plurality scrolling axes being mutually orthogonal;

displaying the plurality of images in respective user interface windows;

5 receiving inputs from a user of the workstation to modify which images of the radiological volume are generated and displayed, pairs of consecutively displayed images for a given scrolling axis being nearest neighbours along that scrolling axis, thereby selecting images of the first radiological volume;

analysing the selected images to identify a part of the brain of the patient
10 that is affected by stroke, said analysis including receiving further inputs from the user;

producing a stroke assessment report of the patient based on the identified part of the brain; and

uploading the stroke assessment report onto the server.

15

6. The method according to any preceding claim wherein the step of analyzing the selected images further comprises the step of

using the received further inputs to draw a region of interest on one of the selected images to indicate the identified part of the brain.

20

7. The method according to claim 6 wherein the step of analyzing the selected images further comprises the step of

computing based on pixel information of the drawn region of interest a volume of the identified part of the brain indicated by the drawn region of interest.

5 8. The method according to claim 7 wherein the pixel information includes at least one of:

a pixel count of the drawn region of interest;

a maximum value of the pixels of the drawn region of interest;

a minimum value of the pixels of the drawn region of interest;

10 a standard deviation of the values of the pixels of the drawn region of interest; and

a mean of the values of the pixels of the drawn region of interest.

9. The method according to any of claims 6 to 8 wherein the step of
15 analyzing the selected images further comprises the step of processing the drawn region of interest with a segmentation technique selected from the group consisting of:

thresholding;

merging anatomical structures;

20 splitting at least one anatomical structure; and

clustering anatomical structures.

10. The method according to any preceding claim wherein the step of analyzing the selected images further comprises the step of

overlying an atlas over one of the selected images in order to identify at least one anatomical landmark.

11. The method according to claim 8 wherein the step of overlying an atlas
5 over one of the selected images of further comprises the steps of, in the corresponding user interface window:

identifying the anterior commissure (AC) and the posterior commissure (PC) of the brain of the patient in the one of the respective selected images of the first or second radiological volumes; and

10 graphically drawing the atlas over the selected image relative to the identified AC and PC.

12. The method according to claim 11 wherein the step of overlying an atlas over the selected image further comprises the steps of, in the corresponding
15 user interface window:

using the received further inputs to adjust at least one bounding box on the selected image, the at least one bounding box demarcating a portion of the brain; and

using the received further inputs to select further images from the
20 corresponding radiological volume, the further images respectively demarcating an inferior and a superior boundary of the brain.

13. The method according to any preceding claim wherein the step of analyzing the selected images further comprises the step of manipulating the

selected images by performing an image adjustment using the received further inputs, the image adjustment being one selected from the group consisting of:

panning of the one of the respective images;

zooming of the one of the respective images; and

5 window leveling of the one of the respective images.

14. The method according to any preceding claim wherein the stroke assessment report further includes an assessment value computed using a stroke scale, the assessment value being indicative of a severity of the stroke.

10

15. The method according to claim 14 further comprising the step of selecting the stroke scale from a plurality of stroke scales before producing the stroke assessment report.

15 16. The method according to claim 15 further comprising the step of switching one of the user interface windows to a text interface to show computation of the assessment value using the stroke scale.

17. The method according to any of claims 1 to 13 further comprising the
20 step of switching one of the user interface windows to an interface selected from the group consisting of:

a text interface;

a video display interface;

a three-dimensional display interface and

an image display interface.

18. A mobile workstation for carrying out the method according to any of claims 1 to 17, the mobile workstation comprising

5 a screen capable of displaying the user interface windows,

a transceiver capable of downloading the part(s) of the radiological volume(s) of the patient from the server, the transceiver further being capable of uploading the stroke assessment report onto the server,

10 an input interface capable of receiving the inputs and the further inputs from the user, and

a processor containing software configured to carry out the method.

19. A server programmed to enable a mobile workstation to carry out the method according to any of claims 1 to 17, the server comprising

15 a transceiver configured to retrieve from another server a list of one or more clinician(s), the one or more clinician(s) each being associated with a corresponding one of a one or more mobile workstation(s); and

a processor containing software for carrying out the method for each of the one or more mobile workstation(s), the software being configured to for
20 each of the one or more mobile workstation(s):

upload via the transceiver the part(s) of the radiological volume(s) from the server to the mobile workstation by pushing the part(s) of the radiological volume(s), the part(s) of the radiological volume(s) being determined based on a specialization of the associated clinician; and

download via the transceiver the stroke assessment report from the mobile workstation.

20. The server according to claim 19 wherein the software is further
5 configured to for each of the one or more mobile workstation(s), process an image of the part(s) of the radiological volume(s) using an image processing algorithm.

21. The server according to claim 19 or 20 wherein the software is further
10 configured to for each of the one or more mobile workstation(s),
record the time when the part(s) of the radiological volume(s) is uploaded to the mobile workstation; and
record the time when the stroke assessment report is downloaded from the mobile workstation.

15

22. A method for diagnosing stroke in a patient at a mobile workstation, the mobile workstation being capable of displaying at least two user interface windows, the method comprising the steps of
downloading at least part of a radiological data of the patient from a
20 server;
displaying the downloaded radiological data in one of the at least two user interface windows, the one of the at least two user interface windows being an interface selected from the group consisting of:

a text interface,

a video display interface,

a three-dimensional display interface, and

an image display interface;

analyzing the displayed radiological data to arrive at a stroke diagnosis;

5 producing a stroke assessment report of the patient based on the stroke

diagnosis; and

uploading the stroke assessment report onto the server.

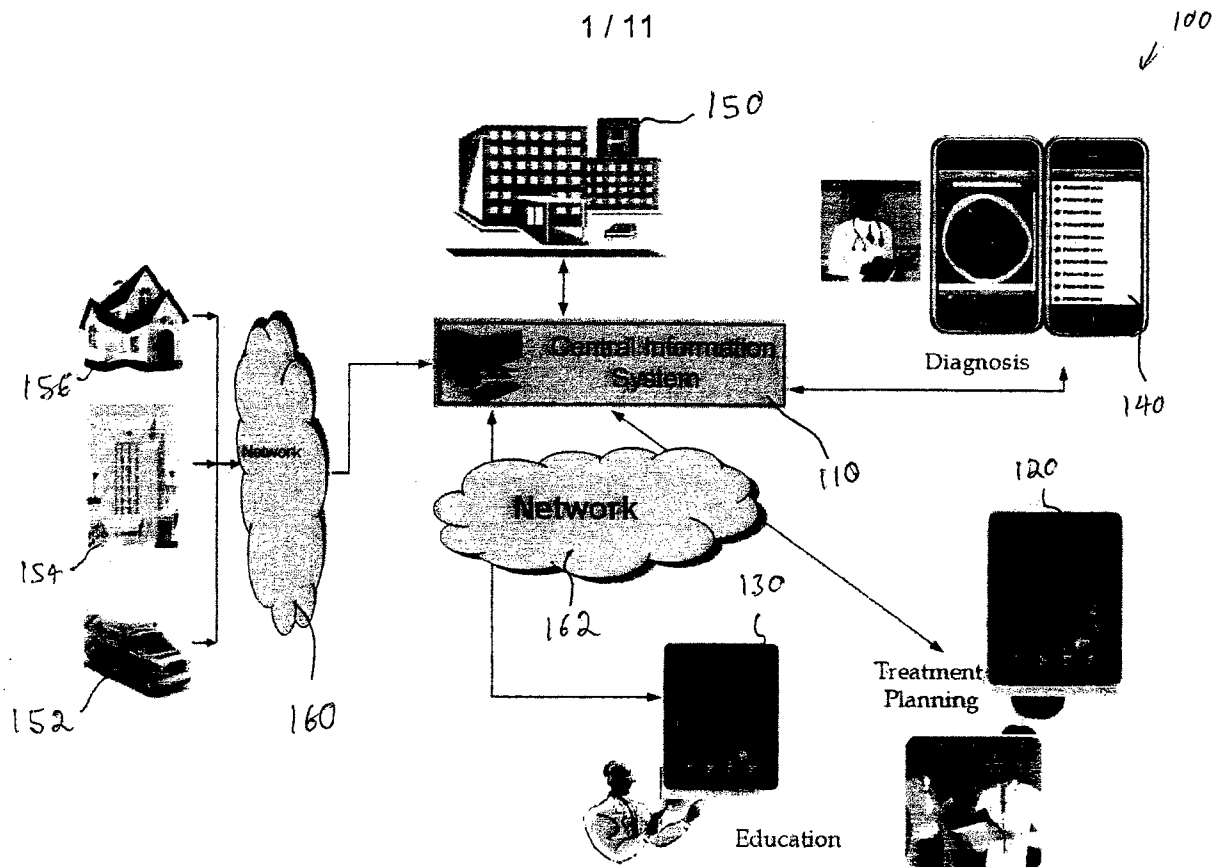


Figure 1

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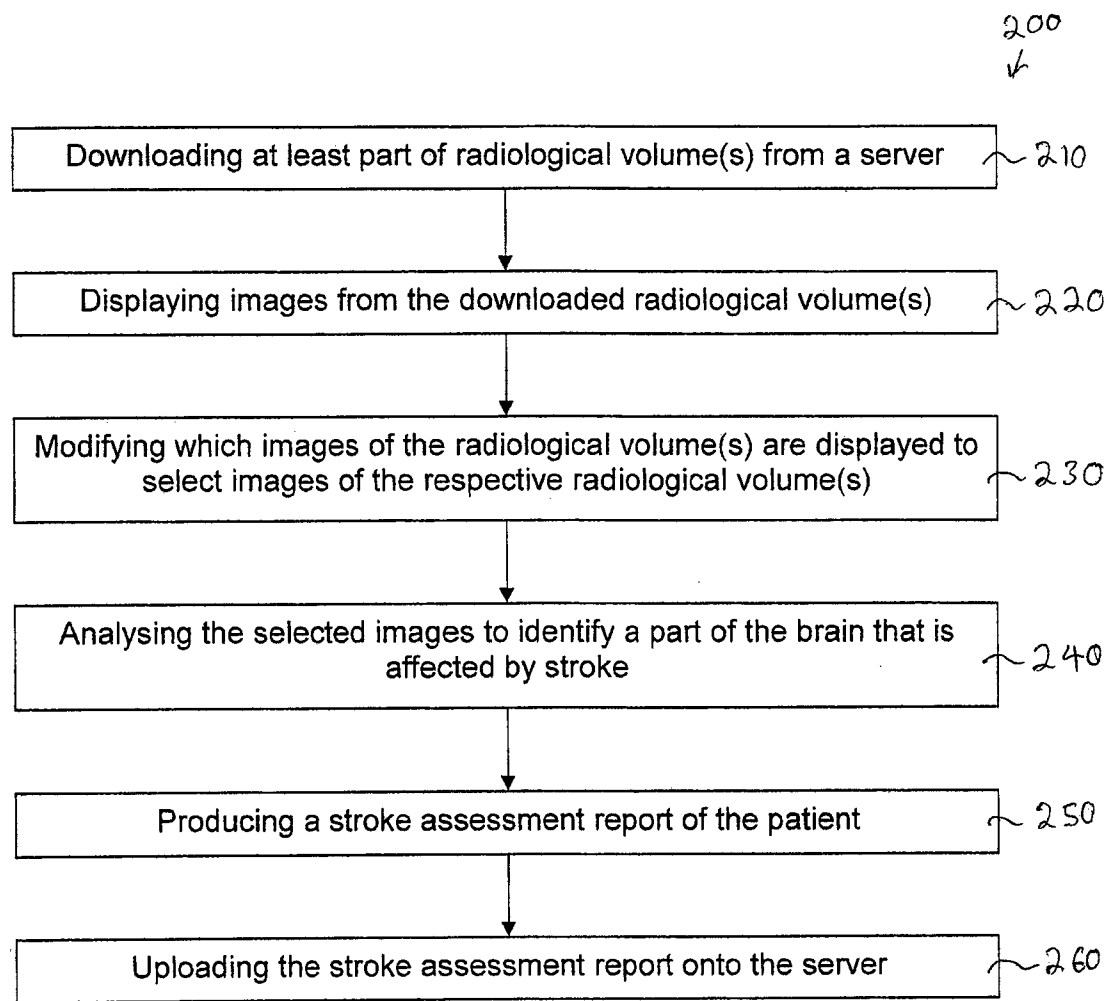


Figure 2

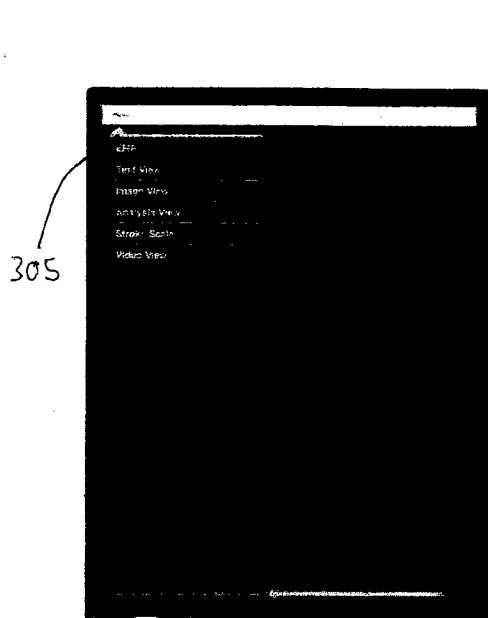


Figure 3a

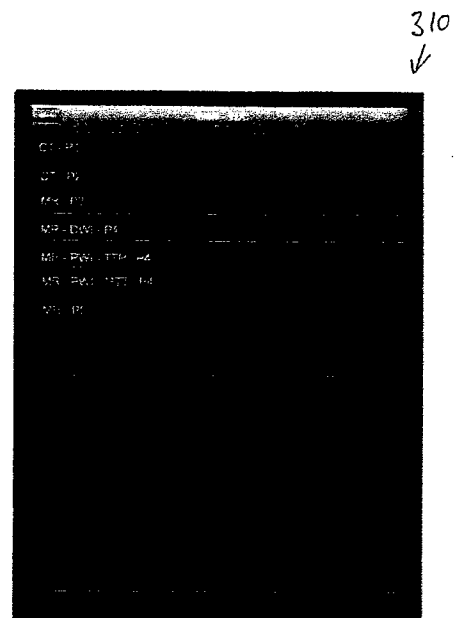


Figure 3b

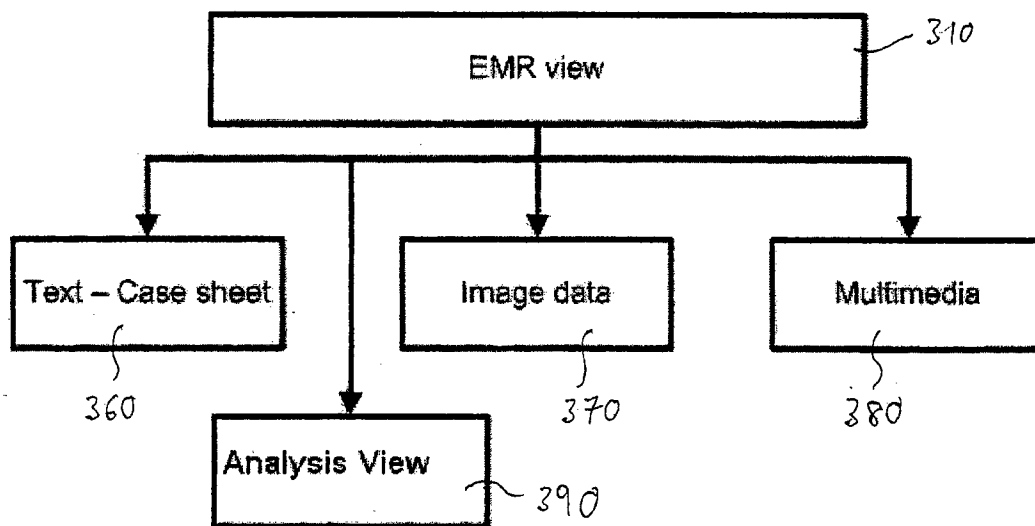


Figure 3c

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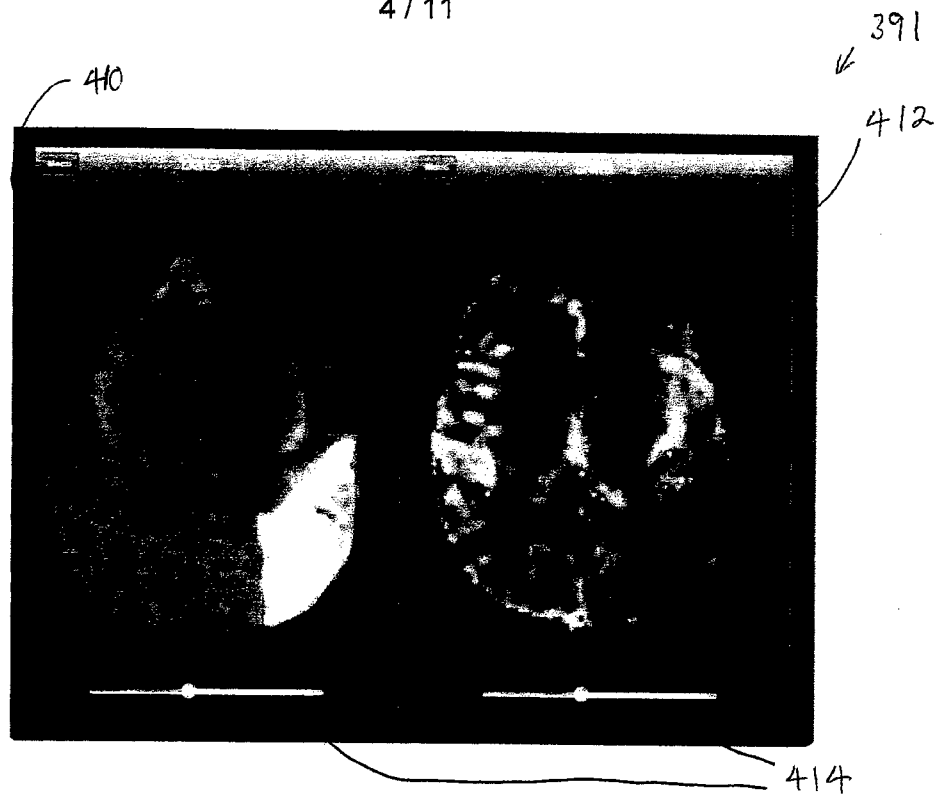


Figure 4a

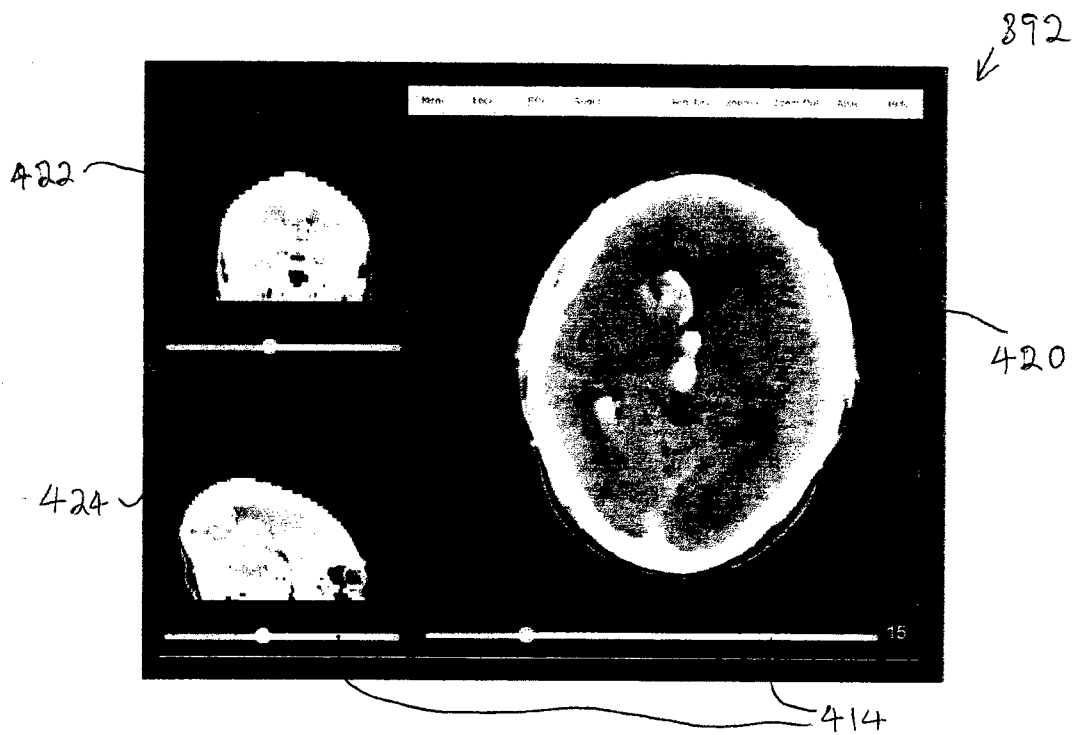


Figure 4b

5 / 11

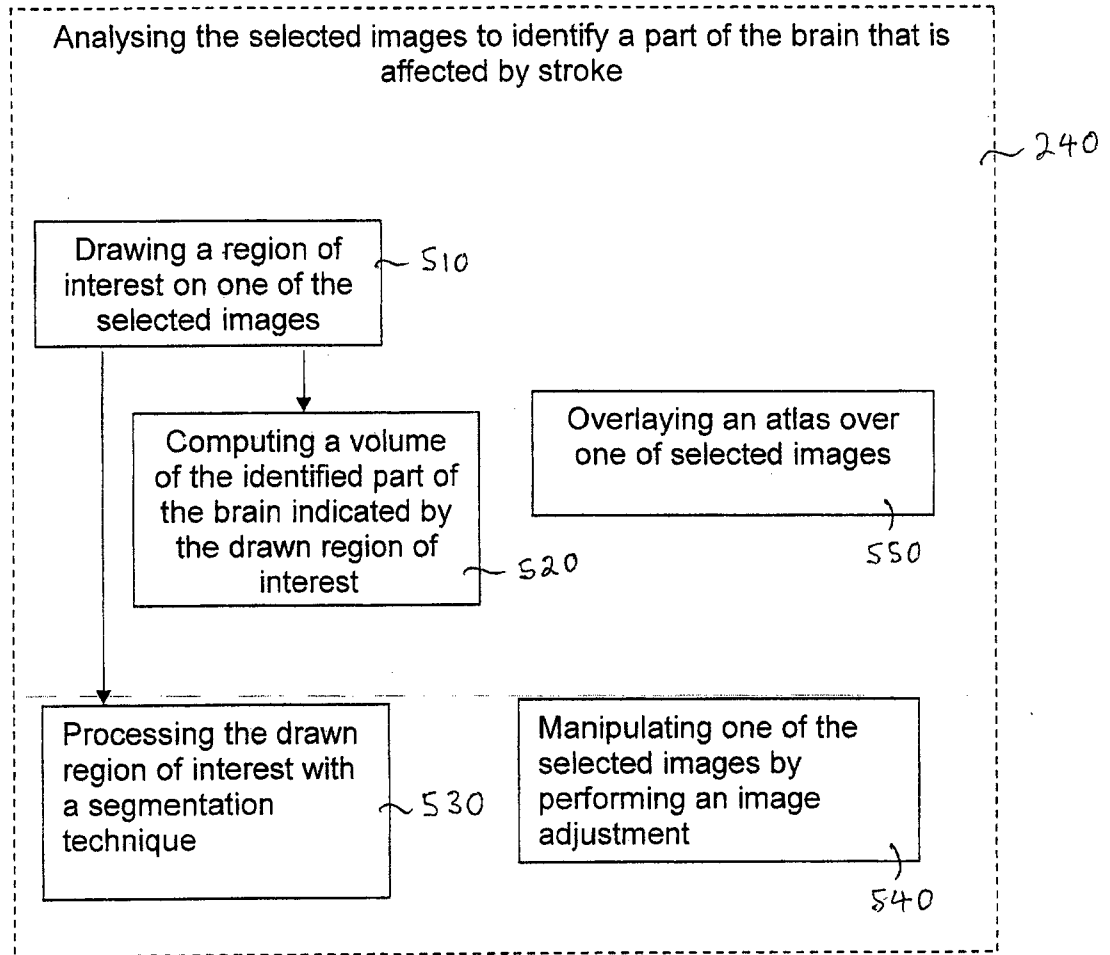


Figure 5

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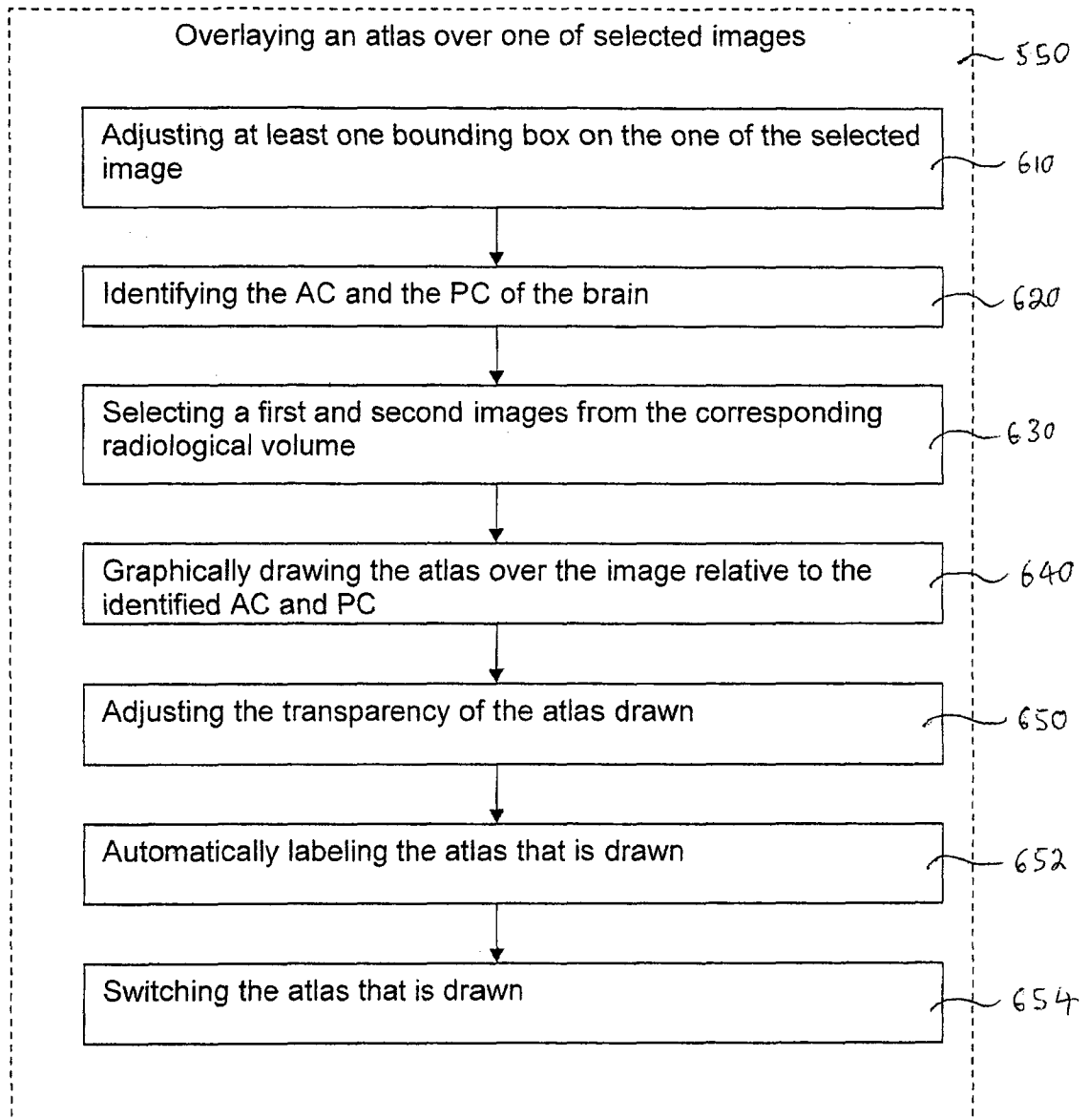


Figure 6

7/11

410

393

↓

412

Stroke Scale

CHA2DS2-VASc Risk	Score
CHF or LVEF $\leq$ 40%	1
Hypertension	1
Age > 75	2
Diabetes	1
Stroke/TIA/ Thromboembolism	2
Vascular Disease	1
Age 65 - 74	1
Female	1

Figure 7a

410

412

393

↓

Stroke Scale

Item	Score	Left	Right	Both	None
1a. Level of Consciousness (best words, eye, verbal)	0-3				
1b. LOC Question (best words, eye, verbal)	0-3				
2. Motor (best words, eye, verbal)	0-3				
3. Motor (best words, eye, verbal)	0-3				
4. Motor (best words, eye, verbal)	0-3				
5a. Motor (best words, eye, verbal)	0-3				
5b. Motor (best words, eye, verbal)	0-3				
6. Motor (best words, eye, verbal)	0-3				
7. Motor (best words, eye, verbal)	0-3				
8. Motor (best words, eye, verbal)	0-3				
9. Motor (best words, eye, verbal)	0-3				
10. Motor (best words, eye, verbal)	0-3				
11. Motor (best words, eye, verbal)	0-3				
12. Motor (best words, eye, verbal)	0-3				
13. Motor (best words, eye, verbal)	0-3				
14. Motor (best words, eye, verbal)	0-3				
15. Motor (best words, eye, verbal)	0-3				
16. Motor (best words, eye, verbal)	0-3				
17. Motor (best words, eye, verbal)	0-3				
18. Motor (best words, eye, verbal)	0-3				
19. Motor (best words, eye, verbal)	0-3				
20. Motor (best words, eye, verbal)	0-3				
21. Motor (best words, eye, verbal)	0-3				
22. Motor (best words, eye, verbal)	0-3				
23. Motor (best words, eye, verbal)	0-3				
24. Motor (best words, eye, verbal)	0-3				
25. Motor (best words, eye, verbal)	0-3				
26. Motor (best words, eye, verbal)	0-3				
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TOTAL SCORE					

Figure 7b

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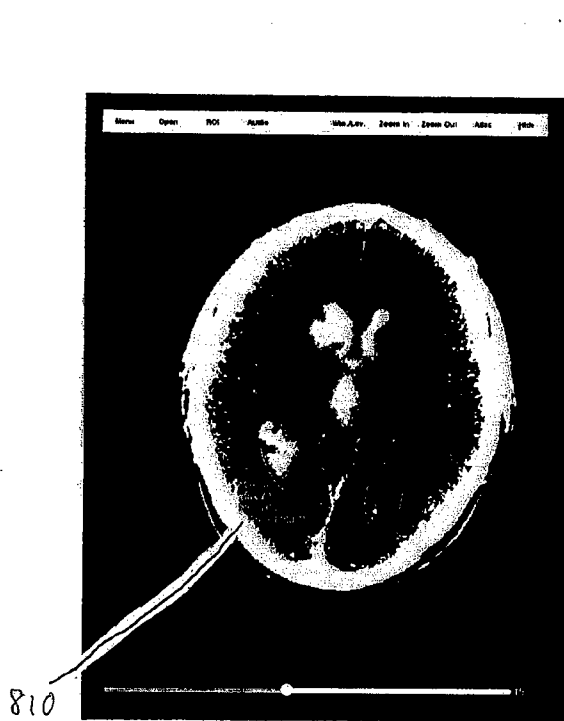


Figure 8a

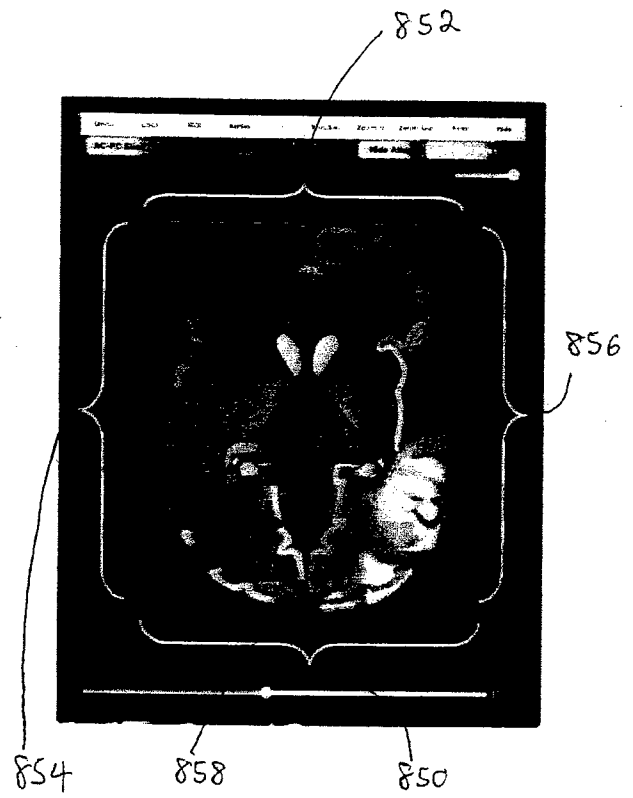


Figure 8b

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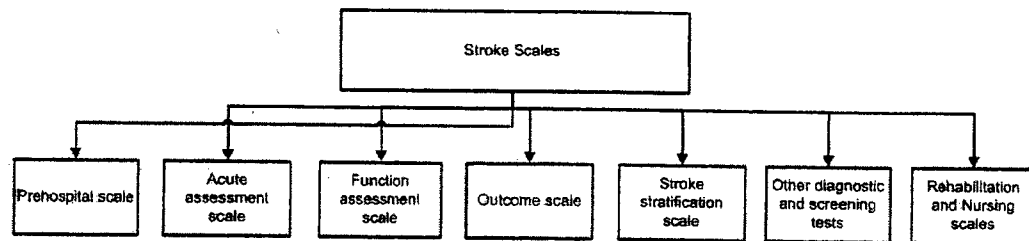


Figure 9

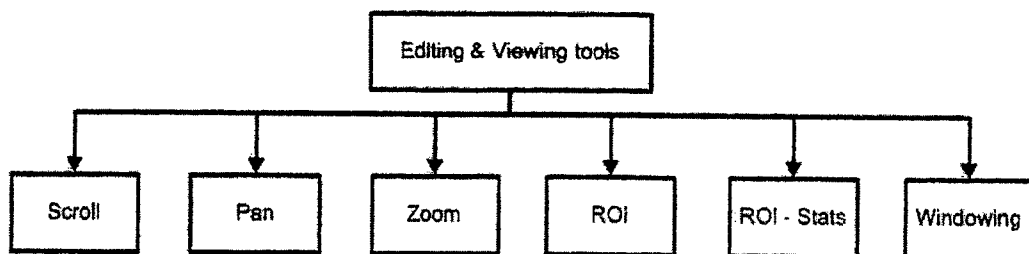


Figure 10

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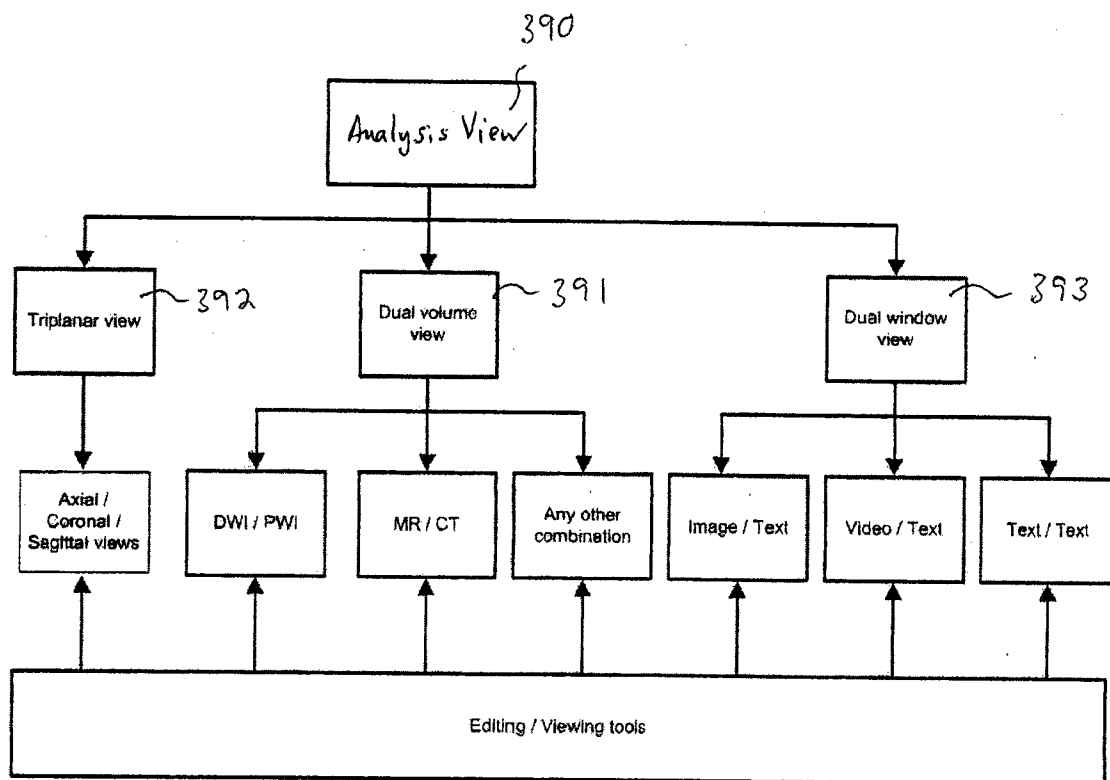


Figure 11

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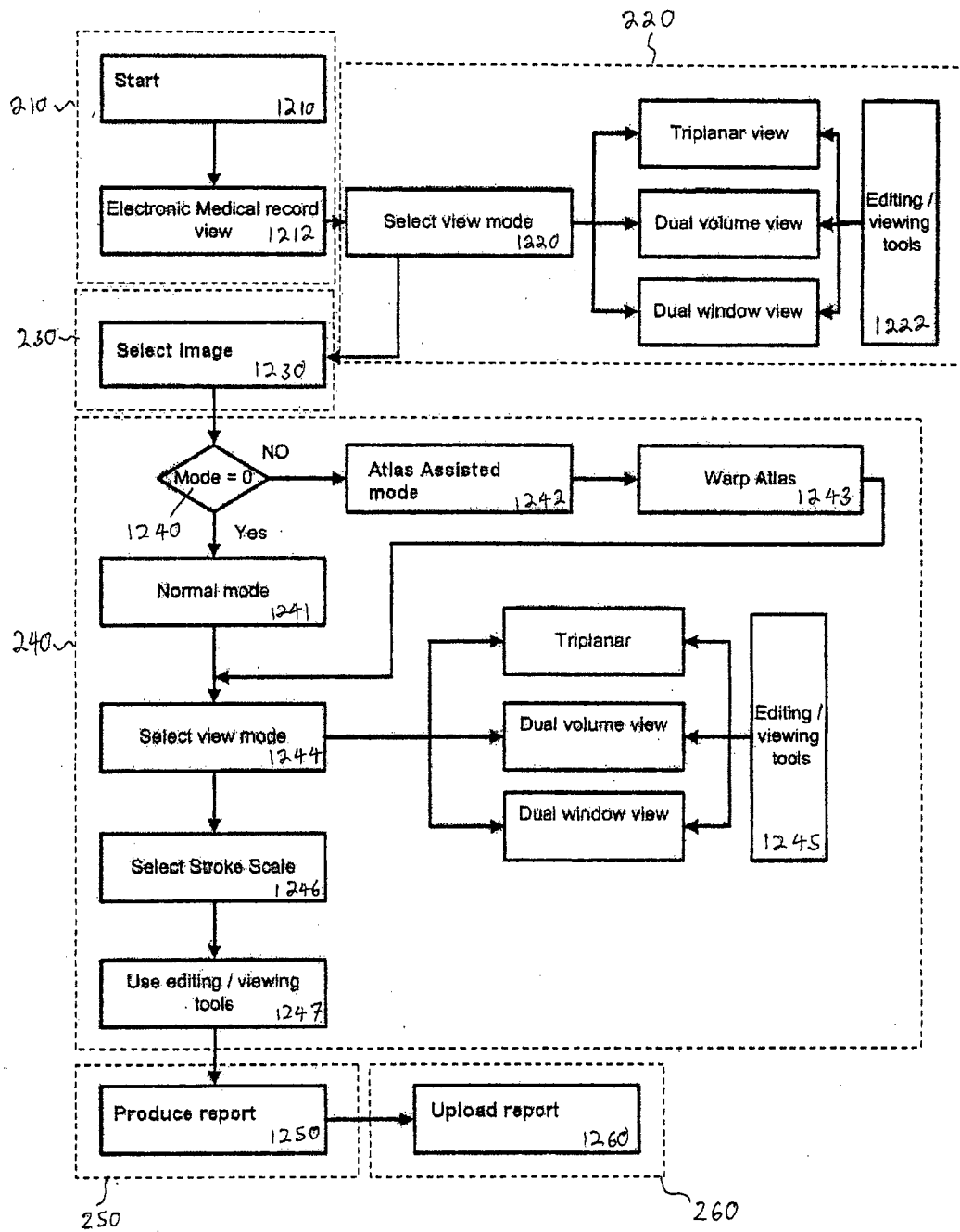


Figure 12

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SG2011/000416

A. CLASSIFICATION OF SUBJECT MATTER		
Int. Cl.		
A61B 6/00 (2006.01) G06T 7/00 (2006.01) G06F 19/26 (2006.01)		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
WPI, EPODOC, Patentlens, PUBMED, Internet		
Keywords: telemedicine, teleradiology, stroke, infarct, assessment, acute, early and similar terms		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2007/0064984 A1 (VASSA et al.) 22 March 2007 Figs. 1 – 4 and paragraphs [0033] – [0039] Figs. 1 – 11 and paragraph [0013] lines 8 to 13	1 – 5 17- 18, 22
Y	Figs. 1 – 4 and paragraphs [0033] – [0039]	6 – 13, 19 - 21
X, Y	US 2009/0034812 A1 (NOWINSKI et al) 5 February 2009 paragraphs [0032] and [0061] paragraphs [0033], [0074], [0089] – [0090] and [0109] lines 12 – 13,	6 – 9 10 – 13
X, Y	US 2005/0113680 A1 (IKEDA et al.) 26 May 2005 fig. 16A and paragraphs [0091] and [0118] – [0120]	6 – 9
A	ADAMS, H. et al., 'Guidelines for the Early Management of Adults with Ischemic Stroke', Stroke. 2007;v38:pp1655-1711.	1 – 13, 17 – 22
☒ Further documents are listed in the continuation of Box C ☒ See patent family annex		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 16 March 2012		Date of mailing of the international search report 20 March 2012
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. +61 2 6283 7999		Authorized officer Leanne Walsh AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No : +61 2 6283 2180

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SG2011/000416

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2010/0256986 A1 (BACKHAUS et al) 7 October 2010 Figs 2 and 3, abstract and paragraphs [0007] and [0058]	19 – 21
A	DE 102009014287 A1 (FASBENDER) 29 July 2010 paragraphs [0006] to [0011]	1 – 13, 17 – 22
A	US 2009/0132963 A1 (MORITA et al) 21 May 2009 Entire document	1 – 13, 17 – 22
A	BIRNS, J et al, 'Telestroke: a concept in practice', Age and Ageing. 2010;v39:pp666-667 Entire document	1 – 13, 17 – 22

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SG2011/000416

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 14 - 16
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically: Article 5 of the PCT Guidelines state the disclosure of the claimed invention to be sufficiently clear and complete allowing it to be carried out by a person skilled in the art. The specification does not define how to determine the severity of a stroke, where severity in itself is a subjective scale and therefore unable to be measured, additionally and the description does not provide clear objective definition or objective determination scale for stroke severity. Therefore the description does not meet the requirements of Article 5 of the PCT as claims 14 to 16 lack clear enabling disclosure of stroke severity
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SG2011/000416

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report			Patent Family Member			
US	2007064984	EP	1764686			
US	2009034813	WO	2009017715			
US	2005113680	CN	1628611	JP	2005131010	JP 2005131011
US	2010256986	AU	2005328324	CA	2636705	EP 1872313
		US	2006195339	US	7729928	US 7925521
		US	2011004490	US	7970634	US 2011191118
		US	8090593	US	2011010192	US 2011015941
		US	2011066449	WO	2006093544	
DE	102009014287	NONE				
US	2009132963	DE	102008037571			
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.						
END OF ANNEX						