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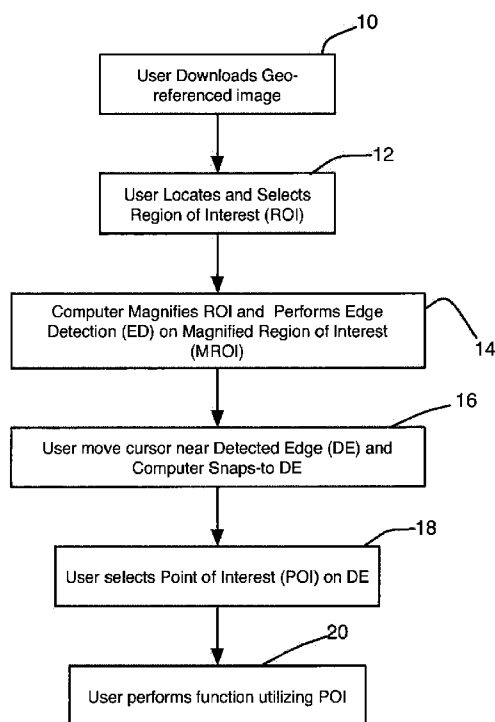
Fig. 1

(57) Abstract: A method for creating image products includes the following steps. Image data and positional data corresponding to the image data are captured and processed to create geo-referenced images. Edge detection procedures are performed on the geo-referenced images to identify edges and produce geo-referenced, edge-detected images. The geo-referenced, edge-detected images are saved in a database. A user interface to view and interact with the geo-referenced image is also provided such that the user can consistently select the same Points of Interest between multiple interactions and multiple users.

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Systems and Methods for Processing Images with Edge Detection and Snap-To Feature

Cross-Reference to Related Applications

[0001]   The present application claims benefit of U.S. Patent Application Serial Number US 12/972,088, filed 17 December 2010 (17/12/2010).

Statement Regarding Federally Sponsored Research or Development

[0002]   Not Applicable.

The Names of the Parties to a Joint Research Agreement

[0003]   Not Applicable.

Background of the Invention

1.   FIELD OF INVENTION

[0004]   The inventive concepts disclosed and claimed herein relate generally to digital image processing and, more particularly, but not by way of limitation, to finding and selecting points of interest on an edge of interest in a digital image.

2.   BRIEF DESCRIPTION OF RELATED ART

[0005]   In the remote sensing/aerial imaging industry, imagery is used to capture views of a geographic area to be able to measure objects and structures within the images as well as to be able to determine geographic locations of points within the image. Such imagery is described in, for example, U.S. Patent Application Publication No. 2008/0231700. Photogrammetry is the science of making measurements of and between objects depicted within photographs, especially aerial photographs. A person, or User, may interact with the image to select Points of Interest that may be used to perform other functions such as: determine distance between two points; determine the area outlined by a set of points; determine the volume of a 3-dimensional shape, or other functions. Usually, the greatest error induced into the calculation of the function is the human error introduced by the User selecting the Points of Interest. For example, if a measurement from a building to the edge of a curb is desired and the User selects a point that is close to the edge of

the building, but not the actual edge of the building, then the measurement will differ from the actual measurement by the distance the User selected away from the building. In the projected image, several pixels could significantly impair the accuracy of the measurement. Additionally, when multiple Users perform the same measurement, their results can differ significantly.

[0006] In light of the foregoing, there is a need for a system and process for allowing a User to select Points of Interest based on the edge elements that exist in a geo-referenced image, wherein the Points of Interest are determined without the error caused by human determination of the position of the edge of an element in an image.

SUMMARY OF THE INVENTION

[0007] A method for creating image products includes the following steps. Image data and positional data corresponding to the image data are captured and processed to create geo-referenced images. Edge detection procedures are performed on the geo-referenced images to identify edges and produce geo-referenced, edge-detected images.

[0008] In one embodiment, a computerized system includes a computer system for storing a database of captured oblique images with corresponding geo-location data and corresponding detected edge data. The computer system has computer executable logic that, when executed by a processor, causes the computer system to receive a selection of a geographic point from a User, search the database to find images that contain the selected point, and make the images that contain the selected point available to the User.

[0009] In another embodiment a method of providing images to a User includes the following steps. A database stores captured oblique images having corresponding geo-location data and corresponding detected edge data. A selection of a geographic point is received from a user and the database is then searched to find images that contain the selected geographic point. The images that contain the selected geographic point are then made available to the User.

[0010] In yet another embodiment a sequence of instructions is stored on at least one non-transitory computer readable medium for running on a computer system capable of displaying and navigating imagery. The sequence of instructions includes instructions for causing the computer system to display a pixel

representation of a georeferenced, edge-detected image, wherein the pixel representation includes one or more detected edges in the geo-referenced, edge-detected image; instructions for causing the computer system to allow the User to select one of the one or more detected edges by moving a cursor over a region of interest (which may be magnified), wherein the cursor is caused to snap-to a selected detected edge when the cursor is within a predetermined distance from the selected detected edge; instructions for causing the computer system to allow the User to accept the selected detected edge as an edge of interest; and instructions for causing the computer system to allow the User to determine and store one or more points of interest along the edge of interest.

[0011]   In yet another embodiment, a system for preparing and utilizing geo-referenced images includes one or more image and data files accessible by a computer system capable of displaying and navigating digital imagery, the image and data file including a plurality of image files, detected edge information corresponding to the plurality of image files, and positional data corresponding to the plurality of image files; and image display and analysis software stored on a non-transitory computer readable medium and executable by the computer system. The image display and analysis software causes the computer system to allow a user to download and display, from the image and data file, a pixel representation of an image having a plurality of detected edges within the image, and to select a detected edge within the pixel representation by moving a cursor over the pixel representation, wherein the cursor is caused to snap-to a selected detected edge when the cursor is within a predetermined distance from the selected detected edge. The image display and analysis software also causes the computer system to allow the user to accept the selected detected edge as an edge of interest; and to allow the user to determine and store one or more points of interest along the edge of interest.

[0012]   Thus, utilizing (1) the technology known in the art; (2) the above-referenced general description of the presently claimed and disclosed inventive concept(s); and (3) the drawings and detailed description of the inventive concepts that follows, the advantages and novelties of the presently claimed and disclosed inventive concept(s) are readily apparent to one of ordinary skill in the art.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]   Like reference numerals in the figures represent and refer to the same element or function. Implementations of the disclosure may be better understood when consideration is given to the following detailed description thereof. Such description makes reference to the annexed pictorial illustrations, schematics, graphs, drawings, and appendices. In the drawings:

[0014]   Figure 1 is a flow chart showing an exemplary process for selecting a Point of Interest on an edge element in a digital photographic image.

[0015]   Figure 2 is a block diagram of an exemplary computer system in accordance with the present disclosure.

[0016]   Figure 3 illustrates an exemplary selection of a region of interest on an image.

[0017]   Figure 4 illustrates an exemplary magnification of the region of interest on an image such that the magnified region of interest is a subset of the entire image and unmagnified surrounding areas are still visible to the User.

[0018]   Figure 5 illustrates an exemplary image showing numerous detected edges.

[0019]   Figure 6 is a flow chart describing a User selection of an edge of interest in an embodiment of the invention.

[0020]   Figure 7 is a flow chart describing a User selection of a point of interest in an embodiment of the invention.

[0021]   Figure 8 illustrates an image showing a selected edge of interest and selected points of interest.

DETAILED DESCRIPTION OF THE INVENTION

[0022]   Before explaining at least one embodiment of the inventive concepts(s) disclosed herein in detail, it is to be understood that the inventive concept(s) is not limited in its application to the details of construction and the arrangement of the components or steps or methodologies set forth in the following description or illustrated in the drawings. The inventive concept(s) disclosed herein is capable of other embodiments or of being practiced or carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein is for the purpose of description and should not be regarded as limiting.

[0023]   In the following detailed description of embodiments of the disclosure, numerous specific details are set forth in order to provide a more thorough understanding of the disclosure. However, it will be apparent to one of ordinary skill in the art that the concepts within the disclosure can be practiced without these specific details. In other instances, well-known features have not been described in detail to avoid unnecessarily complicating the description.

[0024]   The inventive concept(s) disclosed herein is directed to methods and systems of creating image products, wherein image data is captured, along with positional data corresponding to the image data. The image and positional data are processed to create a plurality of geo-referenced images. In one embodiment disclosed herein, edge detection procedures are performed on the plurality of geo-referenced images to identify edges and produce geo-referenced, edge-detected images, which are saved in a database. A computer system storing such a database of captured oblique images having corresponding geo-location data and corresponding detected edge data, has computer executable logic that when executed by a processor causes the computer system to receive a selection of a geographic point from a user, search the database to find images that contain the selected point, and make the images that contain the selected point available to the user. Alternatively, the database may store captured oblique images without the detected edge data, and the edges within such images can be detected in real-time as the user is viewing the image(s).

[0025]   In one embodiment, a sequence of instructions is stored on at least one non-transitory computer readable medium for running on a computer system capable of displaying and navigating imagery. Referring now to the drawings, and in particular to FIG. 1, in general, a User downloads a geo-referenced image as in step 10. The sequence of instructions optionally includes instructions for locating and selecting a user-requested region of interest (ROI) from a downloaded geo-referenced image as in step 12. Further instructions can be provided for magnifying the user-requested region of interest (ROI) to provide a magnified region of interest (MROI) and for performing edge detection procedures on the region of interest (ROI) to provide a detected edge DE as in step 14. However, detected edge data indicative of the detected edge DE can be provided in the downloaded image. The detected edge DE can be either a linear edge or a non-linear edge. In step 16, instructions cause the cursor to snap-to a detected edge (DE) when the User moves

the curser over the MROI and the cursor nears the DE. Further instructions allow the User to determine points of interest (POI) on a selected DE as in step 18. It is known that accuracy of selection of a POI of an element in a digital photographic image can be improved by magnifying the ROI so that the User may select a point as close as humanly possible to the actual edge of the element. However, computerized edge detection is more accurate for determination of an edge of an element and it provides consistency between multiple Users and interactions with the image. It has been discovered that by combining magnification of the ROI with edge detection, ED, and a snap-to utility for the cursor to snap to the detected edge, one can obtain synergistic improvements in the accuracy, precision and consistency of measurements of and between objects depicted within the digital photographic image as in step 20.

[0026]   Referring now to FIG. 2, the User preferably interacts with a first computer system 21 to view and download one or more geo-referenced images to a second computer system 22 (although the geo-referenced images can be stored locally). The first and second computer system 21 and 22 can be a stand-alone computer, one or more computing device(s) and/or a distributed computing system. The stand-alone computer can be a personal computer such as a conventional desktop personal computer, laptop computer or tablet, or a mobile computer terminal. The second computer system 22 preferably includes one or more processor 23, communication connections 24, input devices 26a and 26b, output devices 28a and 28b including a display device 28a, and at least one computer readable medium 30a and 30b. The first computer system 21 can be constructed in a similar manner as the second computer system 22. While the geo-referenced image is often provided by downloading from an Internet site, the geo-referenced image can be provided by accessing any source of data files having image files and positional data corresponding to the images. Image-capturing and geo-locating systems can include image capturing devices, such as, for example, conventional cameras, digital cameras, digital sensors, charge-coupled devices, or other suitable image-capturing devices capable of capturing images photographically or electronically, and positioning information provided by, for example, a global positioning system and/or an inertial navigation unit. These systems and devices are well known to those skilled in the art.

[0027]   The image display and analysis software can be stored on a non-transitory computer readable medium and/or executed by the first and/or the second computer systems 21 and 22   Software providing instructions for displaying a pixel representation of image are available commercially and well known to those skilled in the art.   Image display and analysis software can include methods for utilizing oblique images such as described in U.S. Patent No. 7,787,659, the content of which is incorporated herein by reference.

[0028]   The computer readable mediums 30a and/or 30b includes, for example, non-volatile read only memory, random access memory, hard disk memory, removable memory cards and/or other suitable memory storage devices and/or media. Input devices 26a and 26b, such as, for example, a mouse, keyboard, joystick, or other such input device, enable the input of data and interaction of a User with image display and analysis software being executed by the first and/or the second computer systems 21 and 22.   In one embodiment, the first computer system 21 executes the image display and analysis software, and the second computer system 22 executes a communication software package, such as a web browser, to communicate with the first computer system 21 and display the geo-referenced images.   An output device such as display device 28a can include, for example, a liquid crystal display or cathode ray tube, and displays information to the User of the second computer system 22.   Additional output devices 28b can include a second display device, printer, speaker, etc.   Communication connections 24 connect the second computer system 22 to a network 32, such as, for example, a local-area network, a wide-area network, the Internet and/or the World Wide Web for establishing communication with the first computer system 21.

[0029]   The second computer system 22 typically uses a computer monitor as a display device 28a.   These display devices often cannot display an entire image with the detail necessary. This may be due to the resolution of the information in the image and the resolution and size of the display surface. When a full image is not displayable on the monitor in its entirety, the displayable image which is substituted for the full image is often a global image, i.e. the full image with resolution removed to allow the entire image to fit onto the display surface of the display device. Referring now to FIG. 3 and FIG. 4, to obtain the detail necessary to select a point of interest (POI), algorithms and software have been developed to allow the User to box out a sub-region or region of interest ROI 50 of a photograph or full image 52

and zoom-in or enlarge that sub-region as a magnified region of interest MROI 54, thus allowing the User to select points and lines from an enlarged detail image with greater ease and accuracy.

[0030]   The detail image or magnified region of interest MROI 54 shows the details of the region of interest ROI 50, but when shown alone the global contexts of the details are lost. Thus, in one embodiment, instructions and algorithms known to those skilled in the art are utilized for magnifying a user-requested region of interest (ROI) 50 from the image 52 and displaying the full image or a portion thereof, along with a subsection of the display screen showing a linear magnification of the user-requested ROI 50. This allows for magnification of a particular ROI in an image while preserving visibility of the larger image as shown in FIG 4.

[0031]   In some applications, a non-linear magnification of the user-selected ROI 50 may be provided so that the connection between the detail image and the immediately surrounding portion of the global image is not obscured. Such methods are also known to those skilled in the art. While non-linear magnification creates a "lens" like distortion to the original image, it still provides increased detail for the ROI 50 while maintaining the connection to the immediately surrounding portion of the global image.

[0032]   The User typically interprets the image and decides which features are to be measured. By positioning, for example, a mouse cursor, the approximate location of the features can be pointed out to an algorithm. Semi-automatic feature extraction is known to those skilled in the art and is used for measuring height points as well as for measuring specific object corners. A User positions the cursor at some position in the image 52 and the cursor snaps-to the desired surface or object corner. However, the image around this selected point will usually contain gray value gradients caused by the object edges. Thus the snap-to feature may be limited by the size and quality of the pixels.

[0033]   The extraction of lines from digital images has also been researched for many years. Semi-automatic algorithms have been developed, for example, for the extraction of roads. Most algorithms of this kind are based on so-called "snakes". Extraction of objects like house roofs can be improved by algorithms that extract homogeneous gray value. The algorithms used to find the boundaries of a homogeneous area are usually based on a "region growing algorithm". A common interactive approach is to allow the User to select an appropriate object model, and

approximately align the object model with the image. A fitting algorithm can then be used to find the best correspondence between edges of the object model and the location of high gradients in the image.[1]

[0034]   In an embodiment of the present disclosure, the sequence of instructions stored on at least one computer readable medium 30a, 30b and/or computer readable medium 55 of the first computer system 21 for running on the first and/or second computer systems 21 and 22 capable of displaying and navigating digital imagery includes instructions for performing edge detection procedures on the user-requested region of interest and/or on the entire pixel representation of the image. Referring now to FIG. 5, detected edges 56 can include linear edges 58 as well as curved edges 60. Edge detection is a tool in image processing which identifies discontinuities in a digital image such as points at which the image brightness or color changes sharply. Techniques, procedures and algorithms for edge detection are available commercially and known to those skilled in the art.

[0035]   Referring now to FIG. 6, the sequence of instructions stored on the computer readable mediums 30a, 30b and/or 55 forms a process 98 as discussed below. The process 98 includes instructions for allowing the User to interact with the magnified region of interest MROI 54 as shown in a step 100 to determine points of interest by moving the cursor over the MROI 54. The User interaction can be accomplished with a mouse, touchpad, stylus or other means. Then the first and/or the second computer systems 21 and 22 detect a cursor position as indicated at a step 102. Once the first and /or the second computer systems 21 and 22 detects the cursor position, instructions cause the one or more processor 23 to determine the distance between the cursor and a detected edge DE 56 at a step 104. If the distance is less than a predetermined distance, for example, within 3 pixel lengths, the cursor is caused to snap-to that detected edge DE 56 at a step 106. Snap-to algorithms are known to those skilled in the art.

[0036]   In an embodiment, instructions are provided at a step 108 to hold the cursor at the detected edge DE 56 until the User indicates acceptance or rejection of the detected edge DE 56 as an edge of interest EOI 110 at a step 112. Upon rejection, the cursor is allowed to move freely at a step 114 and the process 98 branches to the step 100 until the cursor position is detected again within a predetermined distance of the same or another detected edge DE 56, at which point the cursor will again snap-to the detected edge DE 56. Upon acceptance of the

detected edge DE 56 as an edge of interest EOI 110, the process 98 includes instructions at a step 116 to indicate, mark and store the accepted edge of interest EOI 32 on the image 52 as shown, for example, in FIG. 8. Acceptance can be indicated by any means of communication with the second computer system 22, such as, for example, by clicking the mouse or by selecting "Accept" from an opened dialog box. Rejection can be indicated similarly or by lack of acceptance for a specified time.

[0037]   Referring now to FIG. 7, the sequence of instructions stored on the computer readable mediums 30a, 30b and/or 55 forms a process 118 as discussed below for proceeding once the User has accepted an edge of interest EOI 110. The process 118 includes instructions for allowing the User to move the cursor along the edge of interest EOI 110 as in a step 121 in order to select a point of interest POI 120. The first and/or the second computer systems 21 and 22 detects the cursor position, and determines whether the cursor is more or less than a predetermined distance from the edge of interest EOI 110 as in a step 122. If the cursor has moved more than the predetermined distance from the edge of interest EOI 110, the process 118 branches back to step 100 in process 98. If the cursor has moved less than the predetermined distance from the edge of interest EOI 110, the User may select a point of interest POI 120 along the detected edge DE forming the edge of interest 110. At a step 124 the User may select a point of interest POI 120 and accept or reject the POI by, for example, double clicking a mouse or by any means of communication with the second computer system 22 as described above for accepting or rejecting the edge of interest EOI 110. If the point of interest POI 120 is rejected, the process 118 braches back to step 122. Upon acceptance of the point of interest POI 120, instructions are provided in a step 126 to indicate, mark and store the accepted point of interest POI 120 on the image as shown, for example, in FIG. 8.

[0038]   The User is then allowed to move the cursor in a step 128 in order to select additional points of interest POI 120. The process 118 queries the User at a step 130 regarding whether all of the points of interest POI 120 have been selected. The User can indicate by any means of communication with the second computer system 22, such as, for example, by selecting "All Done" or "Continue" from an opened dialog box. If additional points of interest POI 120 are desired, process 118 branches back to step 100 of process 98 and additional points of interest POI 120

can be identified using the procedure described above until the User has selected all of the points of interest POI 120 necessary to perform a desired function. If in fact, the User has selected all the necessary points of interest POI 120, the User may select a function to be performed or exit out of the magnified region of interest MROI 54 as in a step 132.

[0039]   Often, the User takes measurements of and between objects depicted in the image 52 by selecting one of several available measuring modes provided within the image display and analysis software. The User selects the desired measurement mode by accessing, for example, a series of pull-down menus or toolbars or via keyboard commands. The measuring modes provided by image display and analysis software may include, for example, a distance mode that enables measurement of the distance between two or more selected points, an area mode that enables measurement of the area encompassed by several selected and interconnected points, a height mode that enables measurement of the height between two or more selected points, and an elevation mode that enables the measurement of the change in elevation of one selected point relative to one or more other selected points.

[0040]   After selecting the desired measurement mode, the User selects a starting point of interest POI 120 and an ending point of interest POI 120' on the image 52, and image display and analysis software automatically calculates and displays the quantity sought. The accuracy, precision and consistency of these measurements depend in great part on the procedure used to select the points of interest POI 120. By combining edge detection procedures with a snap-to function in a magnified region of interest, edges of interest can be identified and individual points of interest along those edges can be selected in a much more accurate and consistent manner than is currently available.

[0041]   In one embodiment disclosed herein, edge detection procedures are performed on the plurality of geo-referenced images to identify edges and produce geo-referenced, edge-detected images which are saved in a database on one or more of the computer readable mediums 30a, 30b and 55. Either the first and/or the second computer system 21 and 22 storing such a database of captured oblique images having corresponding geo-location data and corresponding detected edge data, has computer executable logic that when executed by a processor causes the computer systems 21 and/or 22 to receive a selection of a geographic point from a

user, search the database to find images that contain the selected point, and make the images that contain the selected point available to the user. Alternatively, the database may store captured oblique images without the detected edge data, and the edges within such images can be detected in real-time as the user is viewing the image(s) and/or when the MROI 54 is showing details of a region of interest 50.

[0042]   As it will be appreciated by persons of ordinary skill in the art, changes may be made in the construction and the operation of the various components, elements and assemblies described herein or in the steps or the sequence of steps of the methods described herein without departing from the spirit and scope of the inventive concept(s) disclosed herein.

[0043]   From the above description, it is clear that the inventive concept(s) disclosed herein is well adapted to carry out the objects and to attain the advantages mentioned herein as well as those inherent in the inventive concept(s) disclosed herein. While presently preferred embodiments of the inventive concept(s) disclosed herein have been described for purposes of this disclosure, it will be understood that numerous changes may be made which will readily suggest themselves to those skilled in the art and which are accomplished within the spirit of the inventive concept(s) disclosed and claimed herein.

[0044]   <u>References</u>

[0045]   (1) George Vosselman, "Cartographic Feature Extraction", Delft University of Technology, Delft, The Netherlands.

What is claimed is:

1.   A method of creating image products, comprising the steps of:

capturing image data and positional data corresponding to the image data;

processing the image data and positional data to create a plurality of geo-referenced images;

performing edge detection procedures on the plurality of geo-referenced images to identify edges and produce geo-referenced, edge-detected images; and

saving the geo-referenced, edge-detected images in a data base.

2.   A computerized system, comprising:

a computer system storing a database of captured oblique images having corresponding geo-location data and corresponding detected edge data, the computer system further having computer executable logic that when executed by a processor causes the computer system to receive a selection of a geographic point from a user, search the database to find images that contain the selected point, and make the images that contain the selected point available to the user.

3.   A method of providing images to a user, comprising the steps of:

storing a database of captured oblique images having corresponding geo-location data and corresponding detected edge data;

receiving a selection of a geographic point from a user;

searching the database to find images that contain the selected geographic point; and

making the images that contain the selected geographic point available to the user.

4.   The method of claim 3, further comprising the step of providing a sequence of instructions for storage on at least one non-transitory computer readable medium and for running on a computer system capable of displaying and navigating digital imagery, the sequence of instructions comprising:

instructions for causing the computer system to download and display a pixel representation of one or more of the geo-referenced, edge-detected

images, wherein the pixel representation includes one or more detected edges;

instructions for causing the computer system to allow a user to select one of the one or more detected edges by moving a cursor over the pixel representation, wherein the cursor is caused to snap-to a selected detected edge when the cursor is within a predetermined distance from the selected detected edge;

instructions for causing the computer system to allow the user to accept the selected detected edge as an edge of interest; and

instructions for causing the computer system to allow the user to determine and store a point of interest along the edge of interest.

5.   The method of claim 4, wherein the computer system comprises a personal computer.

6.   The method of claims 4 or 5, wherein the sequence of instructions stored on at least one non-transitory computer readable medium further comprises instructions for causing the computer system to magnify a user-requested region of interest from the displayed pixel representation of the geo-referenced image, and to allow the user to select one of the one or more detected edges from within the magnified user-requested region of interest.

7.   The method of claims 4-6, wherein the sequence of instructions stored on at least one non-transitory computer readable medium further comprises instructions for causing the computer system to display, geolocate and make measurements based on the captured image data and positional data.

8.   The method of claims 4-7, wherein the captured image data are oblique images.

9.   The method of claims 4-7, wherein the sequence of instructions stored on at least one non-transitory computer readable medium further comprises instructions for causing the computer system to display a magnification of a user-

requested region of interest as a subsection of the pixel representation such that a full image is displayed along with a magnified region of interest.

10.   The method of claim 9, wherein the magnification of the user-requested region of interest is linear.

11.   The method of claim 9, wherein the magnification of the user-requested region of interest is non-linear.

12.   The method of claims 4-11, wherein the sequence of instructions stored on at least one non-transitory computer readable medium further comprises instructions for causing the computer system to hold the cursor at the selected detected edge until the user has indicated acceptance or rejection of the selected detected edge as an edge of interest.

13.   The method of claims 4-12, wherein the sequence of instructions stored on at least one non-transitory computer readable medium further comprises instructions for causing the computer system to indicate, mark and store the edge of interest on the image.

14.   The method of claims 4-13, wherein the sequence of instructions stored on at least one non-transitory computer readable medium further comprises instructions for causing the computer system to indicate, mark and store the point of interest on the image.

15.   A sequence of instructions stored on at least one non-transitory computer readable medium for running on a computer system capable of displaying and navigating digital imagery, the sequence of instructions comprising:

> instructions for causing the computer system to display a pixel representation of a geo-referenced, edge-detected image, wherein the pixel representation includes one or more detected edges in the geo-referenced, edge-detected image;

> instructions for causing the computer system to allow the user to select one of the one or more detected edges by moving a cursor over the pixel

representation, wherein the cursor is caused to snap-to a selected detected edge when the cursor is within a predetermined distance from the selected detected edge;

instructions for causing the computer system to allow the user to accept the selected detected edge as an edge of interest; and

instructions for causing the computer system to allow the user to determine and store one or more points of interest along the edge of interest.

16.   The sequence of instructions stored on at least one non-transitory computer readable medium as in claim 15, wherein the computer system comprises a personal computer.

17.   The sequence of instructions stored on at least one non-transitory computer readable medium as in claims 15 or 16, further comprising instructions for causing the computer system to magnify a user-requested region of interest from the displayed pixel representation of the geo-referenced, edge-detected image, and to allow the user to select one of the one or more detected edges from within the magnified user-requested region of interest.

18.   The sequence of instructions stored on at least one non-transitory computer readable medium as in claims 15-17, further comprising instructions for causing the computer system to display, geolocate and make measurements based on geo-referenced, edge-detected images.

19.   The sequence of instructions stored on at least one non-transitory computer readable medium as in claims 15-18, wherein the geo-referenced, edge-detected images comprise oblique images.

20.   The sequence of instructions stored on at least one non-transitory computer readable medium as in claims 15-19, further comprising instructions for causing the computer system to display a magnification of a user-requested region of interest as a subsection of the pixel representation such that a full image is displayed along with a magnified region of interest.

21. The sequence of instructions stored on at least one non-transitory computer readable medium as in claim 20, wherein the magnification of the user-requested region of interest is linear.

22. The sequence of instructions stored on at least one non-transitory computer readable medium as in claim 20, wherein the magnification of the user-requested region of interest is non-linear.

23. The sequence of instructions stored on at least one non-transitory computer readable medium as in claims 15-22, further comprising instructions for causing the computer system to hold the cursor at the selected detected edge until the user has indicated acceptance or rejection of the selected detected edge as an edge of interest.

24. The sequence of instructions stored on at least one non-transitory computer readable medium as in claims 15-23, further comprising instructions for causing the computer system to indicate, mark and store the edge of interest on the image.

25. The sequence of instructions stored on at least one non-transitory computer readable medium as in claims 15-24, further comprising instructions for causing the computer system to indicate, mark and store the one or more points of interest on the image.

26. A system for preparing and utilizing geo-referenced images, the system comprising:

one or more image and data files accessible by a computer system capable of displaying and navigating digital imagery, the image and data file including a plurality of image files, detected edge information corresponding to the plurality of image files, and positional data corresponding to the plurality of image files; and

image display and analysis software stored on a non-transitory computer readable medium and executable by the computer system to cause the computer system to:

allow a user to download and display, from the image and data file, a
pixel representation of an image having a plurality of detected
edges within the image, and to select a detected edge within the
pixel representation by moving a cursor over the pixel
representation, wherein the cursor is caused to snap-to a
selected detected edge when the cursor is within a
predetermined distance from the selected detected edge;

allow the user to accept the selected detected edge as an edge of
interest; and

allow the user to determine and store one or more points of interest
along the edge of interest.

27.   The system of claim 26, further comprising edge detection software
stored on a non-transitory computer readable medium and executable by a
computerized system to cause the computerized system to perform edge detection
procedures on a plurality of image files to provide a plurality of edge-detected image
files for storage on the image and data file.

28.   The system of claims 26 or 27, wherein the computer system
comprises a personal computer.

29.   The system of claims 26-28, wherein the image display and analysis
software includes instructions for causing the computer system to magnify a user-
requested region of interest from the displayed pixel representation of the geo-
referenced image, and allow the user to select one of the one or more detected
edges from within the magnified user-requested region of interest.

30.   The system of claims 26-29, wherein the image display and analysis
software further includes instructions for causing the computer system to display,
geolocate and make measurements based on the captured image data and
positional data.

31.   The system of claim 30, wherein the captured image data are oblique
images.

32.   The system of claims 26-31, wherein the image display and analysis software further includes instructions for causing the computer system to display a magnification of a user-requested region of interest as a subsection of the pixel representation such that a full image is displayed along with a magnified region of interest.

33.   The system of claim 32, wherein the magnification of the user-requested region of interest is linear.

34.   The system of claim 32, wherein the magnification of the user-requested region of interest is non-linear.

35.   The system of claims 26-34, wherein the image display and analysis software further includes instructions for causing the computer system to hold the cursor at the selected detected edge until the user has indicated acceptance or rejection of the selected detected edge as an edge of interest.

36.   The system of claims 26-35, wherein the image display and analysis software further includes instructions for causing the computer system to indicate, mark and store the edge of interest on the image.

37.   The system of claims 26-36, wherein the image display and analysis software further includes instructions for causing the computer system to indicate, mark and store the one or more points of interest on the image.

38.   A sequence of instructions stored on at least one computer readable medium for running on a computer system capable of displaying and navigating digital imagery, the sequence of instructions comprising:

    instructions for magnifying a user-requested region of interest from a displayed pixel representation of an image;

    instructions for performing linear edge detection procedures on the user-requested region of interest to identify one or more detected linear edges within the user-requested region of interest;

instructions for allowing the user to select one of the one or more detected linear edges within the user-requested region of interest by moving a cursor over the magnified region of interest, wherein the cursor is caused to snap-to a selected detected linear edge when the cursor is within a predetermined distance from the selected detected linear edge;

instructions for allowing the user to accept the selected detected linear edge as an edge of interest; and

instructions for allowing the user to determine and store a point of interest along the edge of interest.

39.   The sequence of instructions stored on at least one computer readable medium as in claim 38, wherein the computer system is a personal computer.

40.   The sequence of instructions stored on at least one computer readable medium as in claims 38 or 39, further comprising instructions for downloading and viewing one or more geo-referenced images.

41.   The sequence of instructions stored on at least one computer readable medium as in claims 38-40, further comprising instructions for displaying, geolocating and making measurements based on captured images.

42.   The sequence of instructions stored on at least one computer readable medium as in claim 41, wherein the captured imaged are oblique images.

43.   The sequence of instructions stored on at least one computer readable medium as in claims 38-42, further comprising instructions for displaying a magnification of the user-requested region of interest as a subsection of the image such that a full image is displayed along with a magnified region of interest.

44.   The sequence of instructions stored on at least one computer readable medium as in claim 43, wherein the magnification of the user-requested region of interest is linear.

45. The sequence of instructions stored on at least one computer readable medium as in claim 43, wherein the magnification of the user-requested region of interest is non-linear.

46. The sequence of instructions stored on at least one computer readable medium as in claims 38-45, further comprising instructions to hold the cursor at the selected detected linear edge until the user has indicated acceptance or rejection of the selected detected linear edge as an edge of interest.

47. The sequence of instructions stored on at least one computer readable medium as in claims 38-46, further comprising instructions for indicating, marking and storing the edge of interest on the image.

48. The sequence of instructions stored on at least one computer readable medium as in claims 38-47, further comprising instructions for indicating, marking and storing the point of interest on the image.

49. A sequence of instructions stored on at least one computer readable medium for running on a computer system capable of displaying and navigating oblique imagery, the sequence of instructions comprising:

instructions for displaying a pixel representation of a full image;

instructions for magnifying a user-requested region of interest from the full image, wherein the region of interest is a subset of the full image, wherein unmagnified surrounding areas of the full image are still visible to the user, and wherein the user can interact with the magnified region of interest;

instructions for performing linear edge detection procedures on the magnified region of interest to identify one or more detected linear edges within the region of interest;

instructions for allowing the user to select one of the one or more detected linear edges within the user-requested region of interest by moving a cursor over the magnified region of interest, wherein the cursor is

caused to snap-to a selected detected linear edge when the cursor is within a predetermined distance from the selected detected linear edge;

instructions for allowing the user to accept the selected detected linear edge as an edge of interest;

instructions for allowing the user to determine, indicate, mark and store at least one point of interest along the edge of interest; and

instructions for allowing the user to make measurements based upon the at least one point of interest.
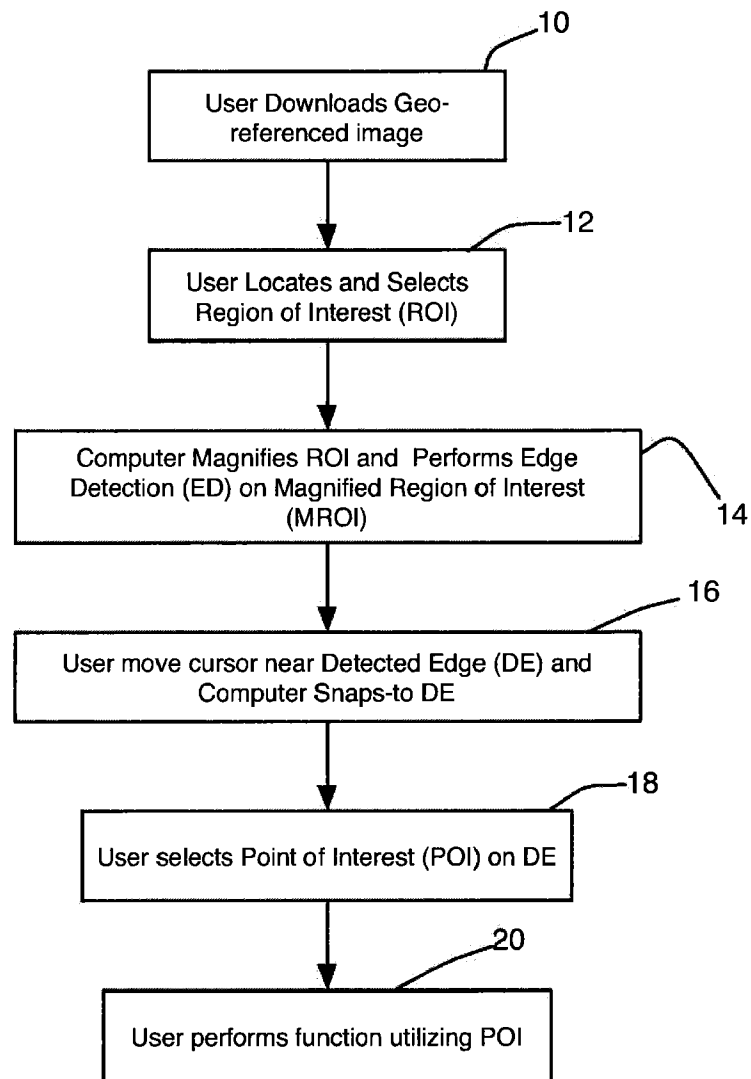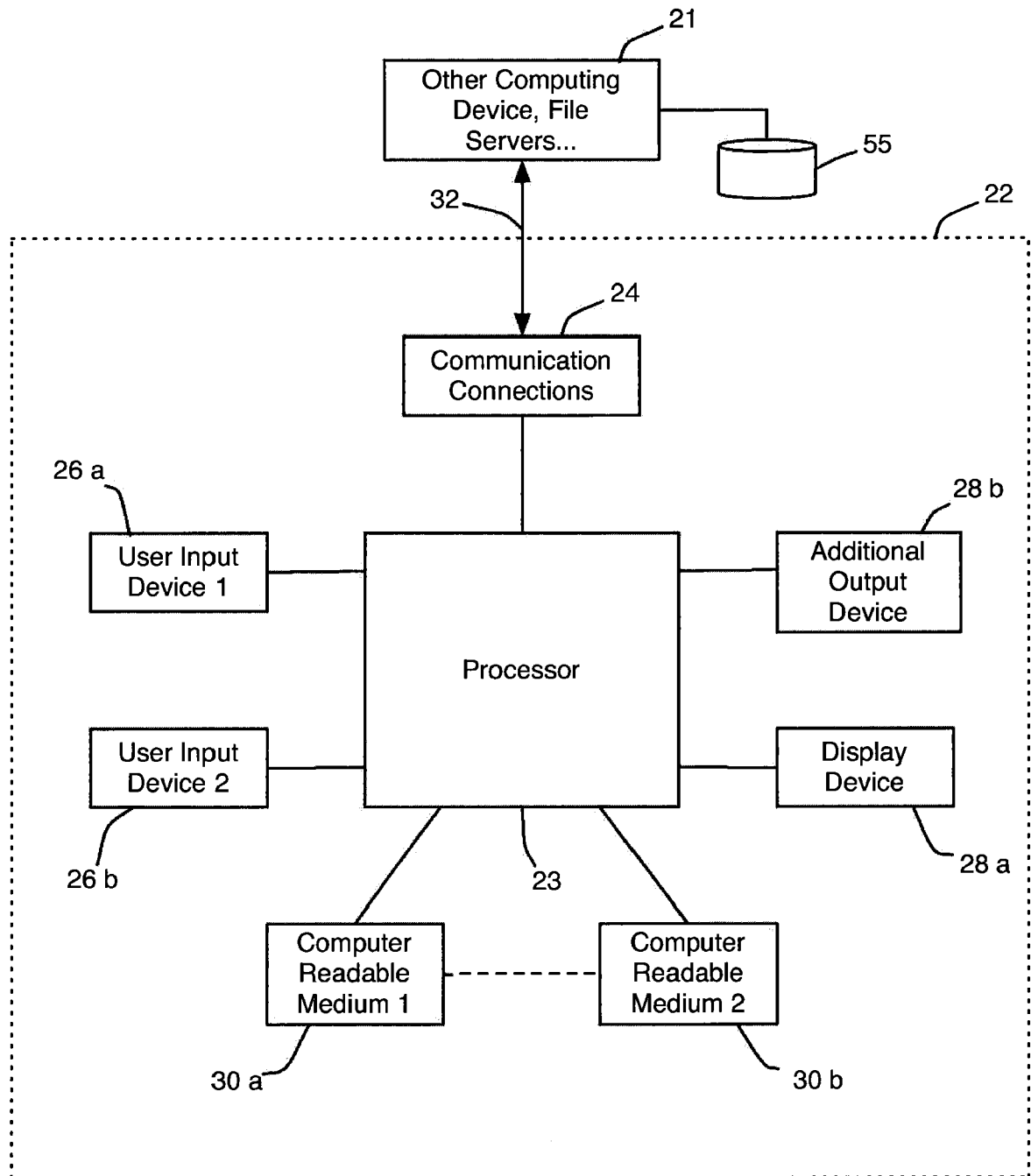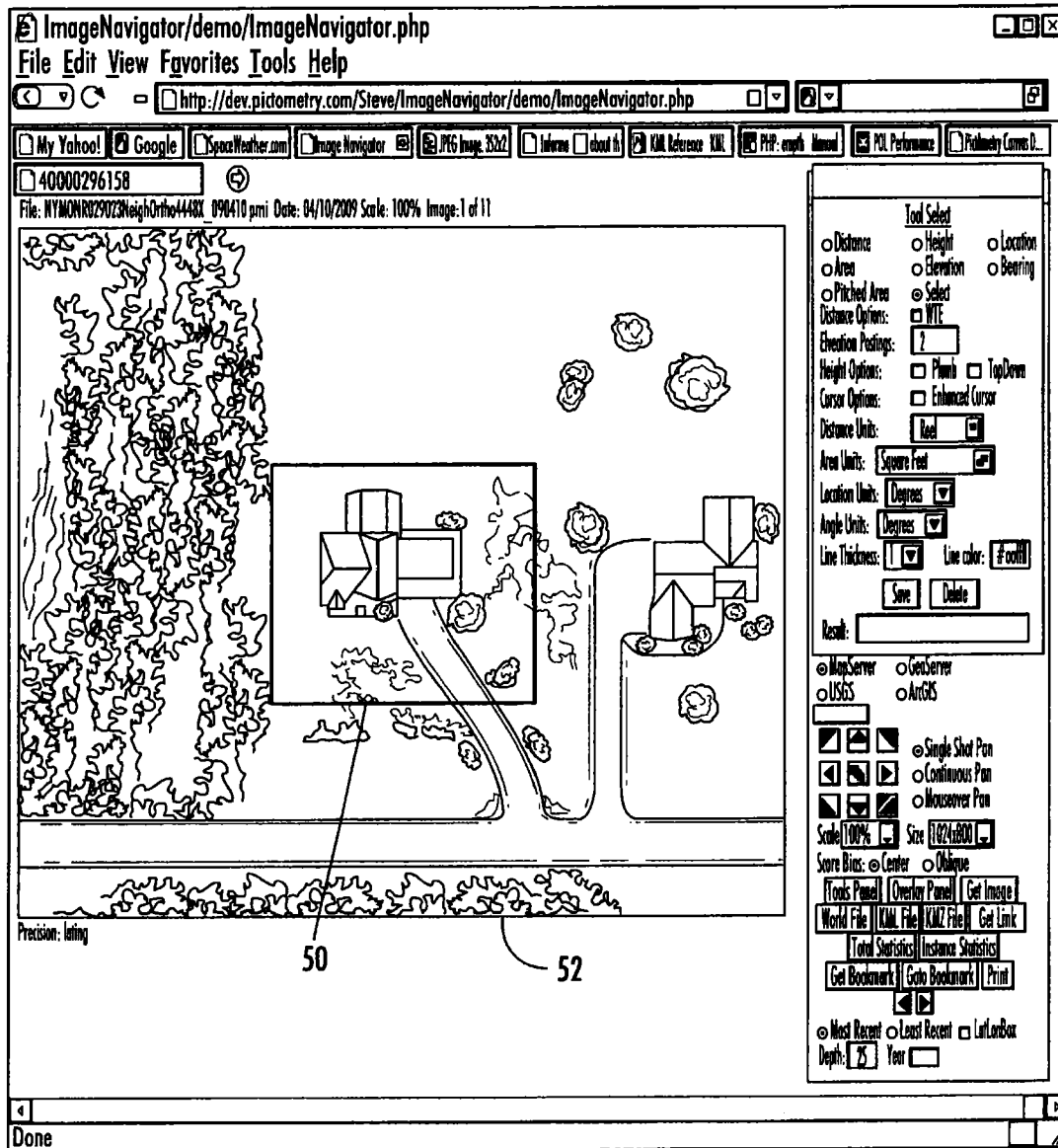
1/8
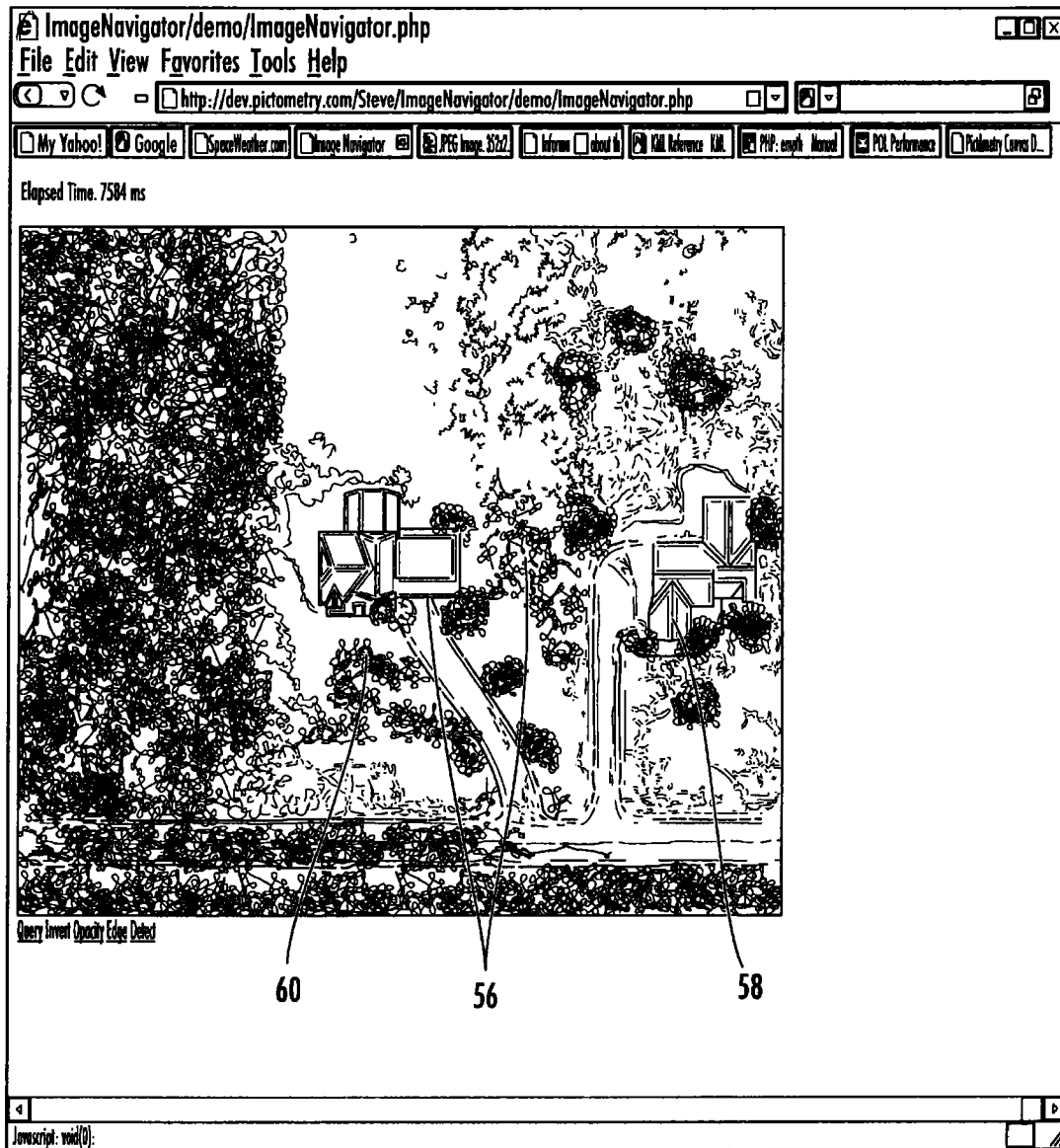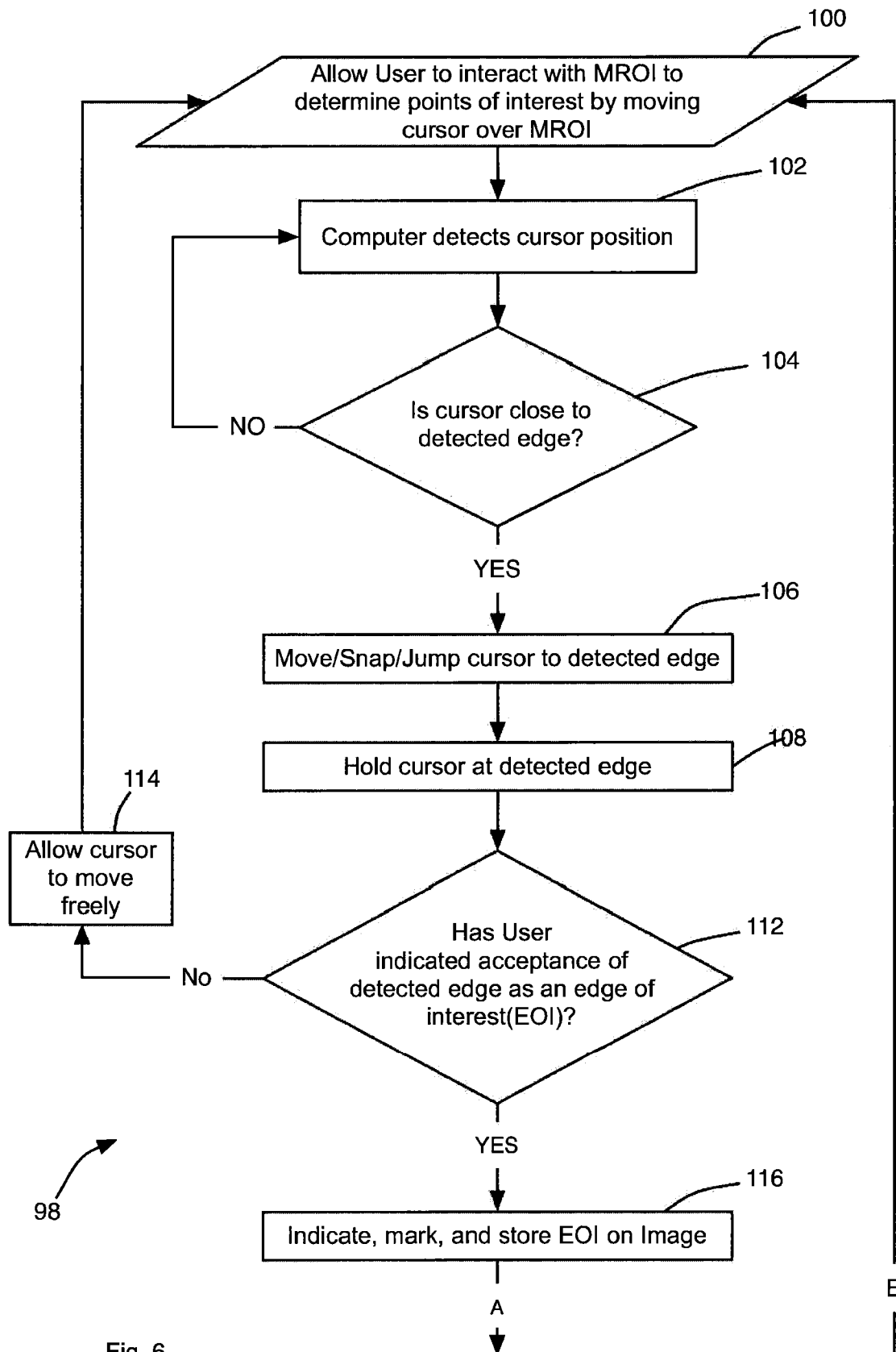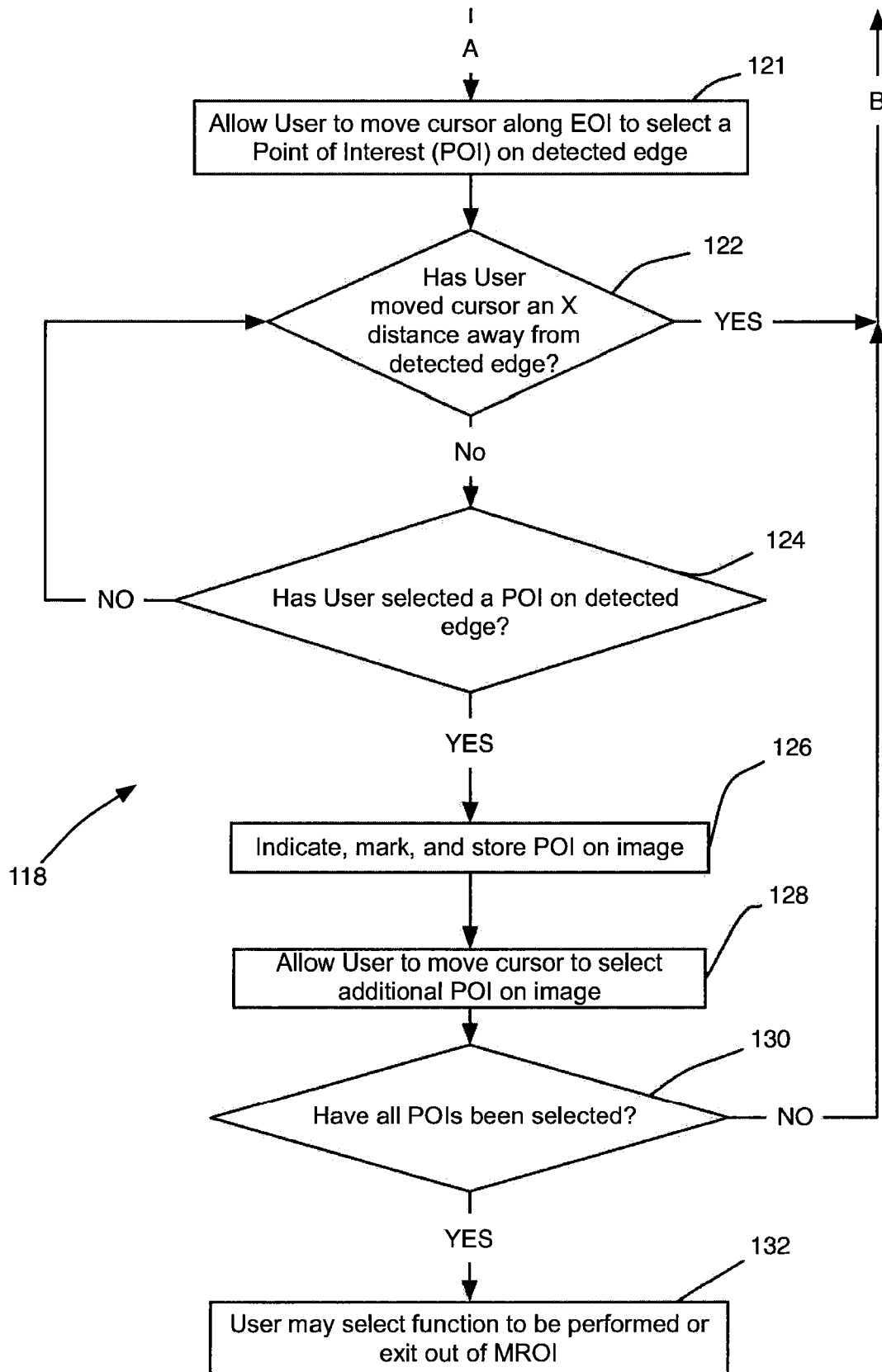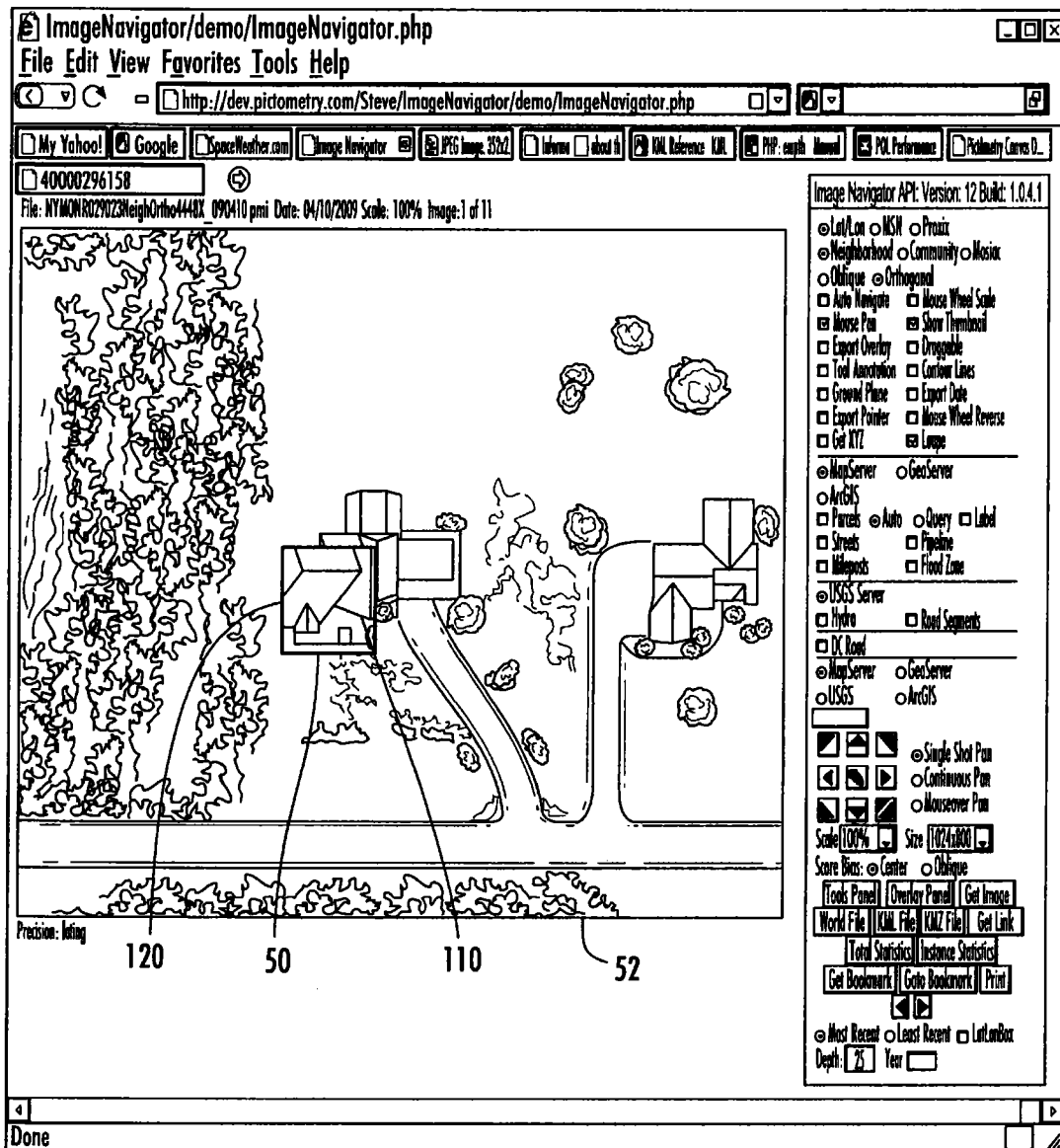
```
                                              ┌─10
        ┌─────────────────────────┐
        │   User Downloads Geo-   │
        │    referenced image     │
        └─────────────────────────┘
                     │
                     │              ┌─12
                     ▼
        ┌─────────────────────────┐
        │  User Locates and Selects│
        │   Region of Interest (ROI)│
        └─────────────────────────┘
                     │
                     ▼
   ┌───────────────────────────────────────┐
   │ Computer Magnifies ROI and  Performs Edge│
   │ Detection (ED) on Magnified Region of Interest│   14
   │              (MROI)                     │
   └───────────────────────────────────────┘
                     │                        ┌─16
                     ▼
   ┌───────────────────────────────────────┐
   │ User move cursor near Detected Edge (DE) and│
   │          Computer Snaps-to DE          │
   └───────────────────────────────────────┘
                     │                    ┌─18
                     ▼
        ┌─────────────────────────┐
        │ User selects Point of Interest (POI) on DE│
        └─────────────────────────┘
                     │              ┌─20
                     ▼
        ┌─────────────────────────┐
        │ User performs function utilizing POI│
        └─────────────────────────┘
```

Fig. 1

Fig. 2

FIG. 3
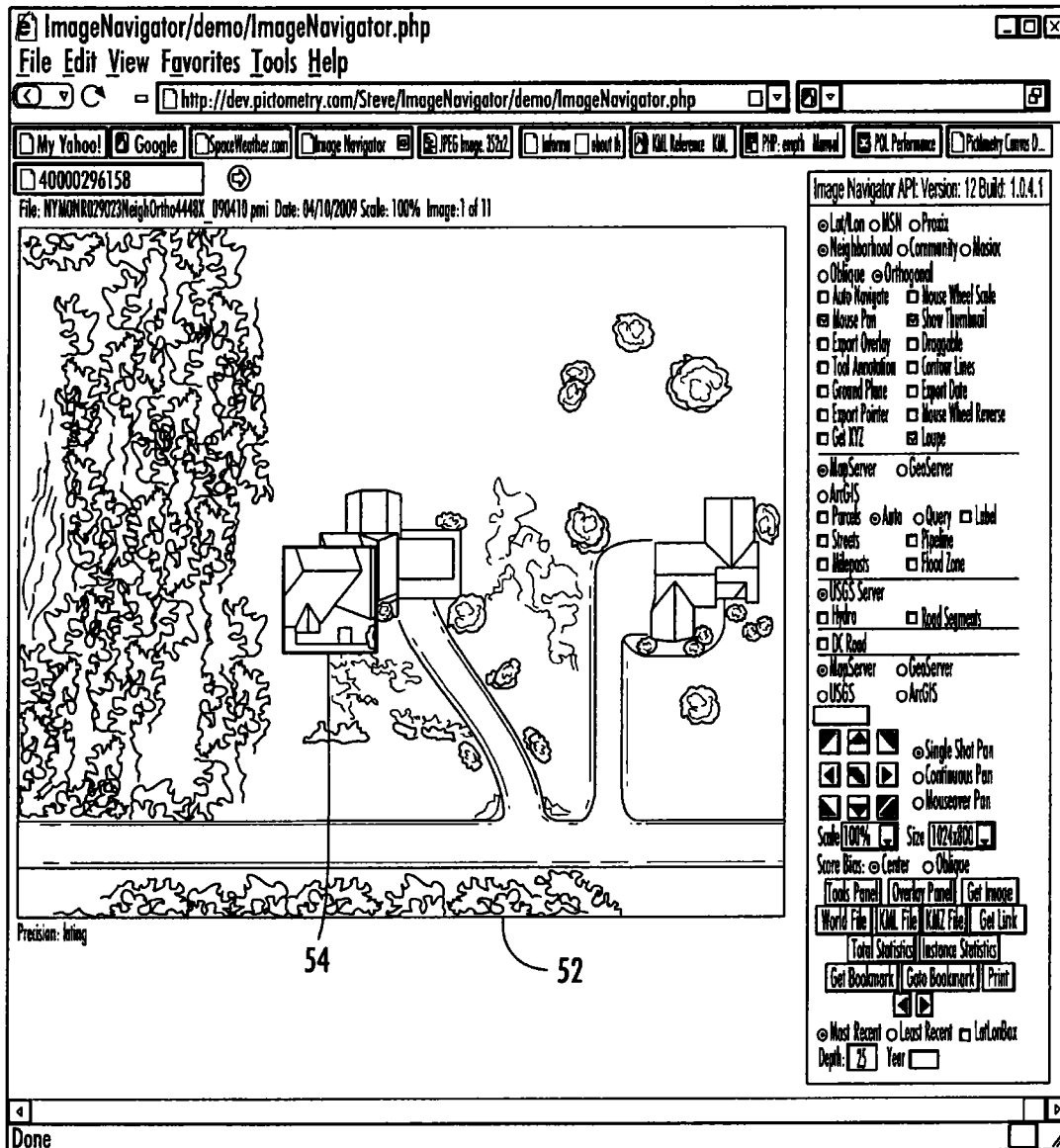
FIG. 4

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FIG. 5

Fig. 6

Fig. 7

FIG. 8

A.	CLASSIFICATION OF SUBJECT MATTER

G06T 11/00(2006.01)i, H04N 5/262(2006.01)i, G06F 17/40(2006.01)i

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)
G06T 11/00; G06F 3/048; G06T 15/00; G06F 15/50; G06T 1/00; G09B 29/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: oblique, geographic, edge, cursor

C.	DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 11-328378 A (HITACHI LTD) 30 November 1999 See paragraph [0018] - paragraph [0045]; claims 1, 2 and figure 1.	1 2-5,7-16,18-28 ,30-37 6,17,29,38-49
Y A	US 2009-0249257 A1 (BOVE THOMAS et al.) 01 October 2009 See paragraph [0046] - paragraph [0047]; claim 1 and figures 1, 3.	2-5,7-16,18-28 ,30-37 6,17,29,38-49
A	US 2007-0024612 A1 (BALFOUR ROBERT E.) 01 February 2007 See abstract; claim 1 and figure 2.	1-49
A	US 2010-0085350 A1 (MISHRA PRAGYANA K. et al.) 08 April 2010 See abstract; claim 1 and figures 1, 4.	1-49
A	US 05381338A A (WYSOCKI; DAVID A. et al.) 10 January 1995 See abstract; claim 1 and figure 1.	1-49

☐ Further documents are listed in the continuation of Box C.	☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority
"A" document defining the general state of the art which is not considered to be of particular relevance	date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent but published on or after the international filing date	"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
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)	"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
"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	"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 MAY 2012 (29.05.2012)	**30 MAY 2012 (30.05.2012)**

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Facsimile No. 82-42-472-7140	Telephone No. 82-42-481-8529

Form PCT/ISA/210 (second sheet) (July 2009)

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 11-328378 A	30.11.1999	JP 3776591 B2	17.05.2006
US 2009-0249257 A1	01.10.2009	CN 102016783 A EP 2260369 A1 KR 10-2010-0125444 A KR20100125444A WO 2009-122005 A1	13.04.2011 15.12.2010 30.11.2010 30.11.2010 08.10.2009
US 2007-0024612 A1	01.02.2007	US 7554539 B2	30.06.2009
US 2010-0085350 A1	08.04.2010	None	
US 05381338A A	10.01.1995	WO 93-00647 A2	07.01.1993