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(54) Title: LOCATING POSITION WITHIN ENCLOSURE

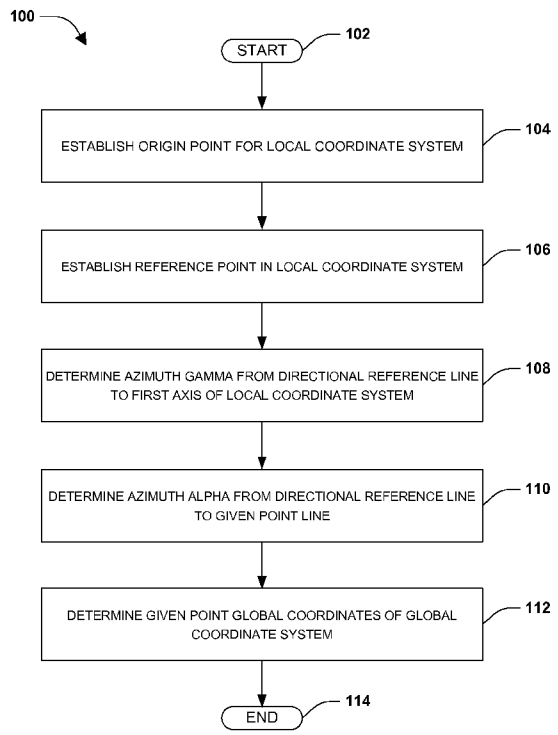

FIG. 1

(57) Abstract: Among other things, one or more techniques and/or systems are provided for locating a position within an enclosure. In one example, known global coordinates (e.g., GPS coordinates of latitude/longitude) associated with the position within the enclosure may be transformed into local coordinates (e.g., x/y coordinates) for the position. The local coordinates may be used for tracking a location of the position within the enclosure. In another example, known local coordinates of the position within the enclosure may be transformed into global coordinates for the position, which may be used for tracking a location of the position within the enclosure. In another example, a blueprint image of the enclosure may be used to track a location of the position within the enclosure. In this way, location tracking may be provided for objects within indoor spaces (e.g., a mapping application may track a current position of a mobile device within a building).

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LOCATING POSITION WITHIN ENCLOSURE

BACKGROUND

[0001] Many devices provide location-based services that utilize position tracking. In one example, a mapping service on a mobile phone may utilize global coordinates (e.g., positional information, such as longitude and latitude, from a global positioning system (GPS)) to identify a current location of the mobile phone. In this way, the user may plan a travel route from the current location to a particular destination of interest to the user. In another example, a restaurant application on a tablet device may utilize positional information, such as global coordinates, to suggest local restaurants to a user. Current position tracking techniques utilize global coordinates associated with GPS because GPS may provide relatively accurate longitude and latitude information for outdoor spaces. However, GPS may not accurately represent indoor locations because GPS may not be able to identify locations within enclosures, such as buildings. In this way, location-based services may be limited to tracking outdoor positions.

SUMMARY

[0002] This summary is provided to introduce a selection of concepts in a simplified form that are further described below in the detailed description. This Summary is not intended to identify key factors or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

[0003] Among other things, one or more systems and/or techniques for locating a position within an enclosure are provided herein. That is, a position (e.g., a location of an object, such as a mobile device, a person, an entity, a portion of a building, etc.) may be located within an enclosure (e.g., an underground structure, a subway, a floor of a building, etc.), such that the position may be tracked within indoor spaces without losing location-based functionality. In this way, a user of a mobile device may seamlessly transition between indoor and outdoor spaces, for example. It may be appreciated that an example of various angles, lines, points, and/or other features described in the summary are illustrated in Fig. 3 for illustrative purposes.

[0004] In one example of locating a position within an enclosure, local coordinates associated with the enclosure may be used to determine global coordinates of a given point as the position within the enclosure. That is, an origin point for a local coordinate system (e.g., a first position within a building, such as a corner of the building, may represent an origin of a Cartesian coordinate system associated with the building) may be established

based upon origin point global coordinates of a global coordinate system for the origin point. For example, a GPS device, associated with the corner of a building, may provide the origin global coordinates of the origin point. A reference point in the local coordinate system (e.g., a second position within the building, such as a second corner of the building, may correspond to a location of the reference point within the building) may be established based upon reference point global coordinates of the global coordinate system for the reference point. For example, a GPS device, associated with the second corner of the building, may provide the reference point global coordinates of the reference point.

[0005] A directional reference line (e.g., true north) may be established for the enclosure based upon the global coordinate system. A first axis (e.g., a y axis) for the local coordinate system may be established based upon the origin point. In this way, an azimuth gamma (e.g., an angle from the directional reference line to the first axis) of the local coordinate system may be determined based upon the origin point and/or the reference point. For example, an azimuth beta (e.g., an angle from the directional reference line to a reference point line that connects the origin point to the reference point) and an angle delta (e.g., an angle from the first axis to the reference point line) may be used to determine the azimuth gamma. In this way, the azimuth gamma may be determined. An azimuth alpha (e.g., an angle from the directional reference line to a given point line that connects the origin point to the given point within the enclosure) may be determined. For example, an angle theta (e.g., an angle from the first axis to the given point line) and the azimuth gamma may be used to determine the azimuth alpha. Accordingly, given point global coordinates of the global coordinate system may be determined for the given point as the position within the enclosure. The given point global coordinates may be determined based upon the azimuth alpha, the origin point global coordinates, and/or a given point line length of the given point line, for example. In this way, local coordinates associated with the enclosure may be used to determine global coordinates of the position of the given point within the enclosure.

[0006] In another example of locating a position within an enclosure, global coordinates associated with the enclosure may be used to determine local coordinates of a given point as the position within the enclosure. That is, origin point global coordinates of a global coordinate system (e.g., coordinates obtained from GPS) and/or origin point local coordinates of a local coordinate system may be obtained for an origin point associated with the enclosure (e.g., an origin, corresponding to a first position within a building, for the local coordinate system associated with the building). Reference point global

coordinates of the global coordinate system (e.g., coordinates obtained from GPS) and/or reference point local coordinates of the local coordinate system may be obtained for a reference point associated with the enclosure (e.g., a point at a second position within the building).

[0007] A directional reference line (e.g., true north) may be established for the enclosure based upon the global coordinate system. A first axis (e.g., a y axis) for the local coordinate system may be established based upon the origin point. In this way, an azimuth gamma (e.g., an angle from the directional reference line to the first axis) of the local coordinate system may be determined based upon the origin point and/or the reference point. An azimuth alpha (e.g., an angle from the directional reference line to a given point line that connects the origin point to the given point within the enclosure) may be determined. A given point line length of the given point line, that connects the origin point to the given point, may be determined. An angle theta (e.g., an angle from the first axis to the given point line) may be determined based upon the azimuth gamma and/or the azimuth alpha. Accordingly, given point local coordinates of the local coordinate system may be determined for the given point as the position within the enclosure. The given point local coordinates may be determined based upon the angle theta and/or the given point line length. In this way, global coordinates associated with the enclosure may be used to determine local coordinates of the position of the given point within the enclosure.

[0008] In another example of locating a position within an enclosure, a blueprint image of an enclosure may be used to determine coordinate points of a position (e.g., a position corresponding to a mobile device) within the enclosure. That is, the blueprint image of a level of the enclosure may be obtained (e.g., a blueprint image comprising pixels that represent a floor of a building). Because the blueprint image may represent the level using pixels, a set of scale parameters for the blueprint image may be used to convert between pixel values and physical coordinates. The set of scale parameters may map pixels of the blueprint image to physical coordinate measurements of the enclosure. A first perpendicular distance from the position within the enclosure to a first structure may be determined (e.g., a first distance from the mobile device to a first wall of the building). A second perpendicular distance from the position to a second structure may be determined (e.g., a second distance from the mobile device to a second wall of the building). In this way, a first circle may be generated based upon the first perpendicular distance using the set of scale parameters (e.g., the first circle may be generated using the first perpendicular distance as a radius), and a second circle may be generated based upon the second

perpendicular distance using the set of scale parameters (e.g., the second circle may be generated using the second perpendicular distance as a radius).

[0009] The position of the first circle and/or the second circle may be translated within the blueprint image, such that the first circle and the second circle are tangential to the first structure and the second structure. For example, a first location for the first circle may be defined, such that the first circle is tangential to the first structure (e.g., the first circle may be moved to the first location within the blueprint image, such that the first circle is tangential to the first wall of the building). A second location for the second circle may be defined, such that the second circle is tangential to the second structure (e.g., the second circle may be moved to the second location within the blueprint image, such that the second circle is tangential to the second wall of the building). In this way, coordinate points of the position within the enclosure may be determined based upon coordinates of the first circle and/or coordinates of the second circle (e.g., based upon center values of the first circle and/or second circle).

[0010] To the accomplishment of the foregoing and related ends, the following description and annexed drawings set forth certain illustrative aspects and implementations. These are indicative of but a few of the various ways in which one or more aspects may be employed. Other aspects, advantages, and novel features of the disclosure will become apparent from the following detailed description when considered in conjunction with the annexed drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Fig. 1 is a flow diagram illustrating an exemplary method of locating a position within an enclosure.

[0012] Fig. 2 is a flow diagram illustrating an exemplary method of locating a position within an enclosure.

[0013] Fig. 3 is an illustration of an example of a representation of an enclosure.

[0014] Fig. 4 is a component block diagram illustrating an exemplary system for generating one or more circles used for locating a position within an enclosure.

[0015] Fig. 5 is a component block diagram illustrating an exemplary system for locating a position within an enclosure.

[0016] Fig. 6 is an illustration of an exemplary computer-readable medium wherein processor-executable instructions configured to embody one or more of the provisions set forth herein may be comprised.

[0017] Fig. 7 illustrates an exemplary computing environment wherein one or more of the provisions set forth herein may be implemented.

DETAILED DESCRIPTION

[0018] The claimed subject matter is now described with reference to the drawings, wherein like reference numerals are generally used to refer to like elements throughout. In the following description, for purposes of explanation, numerous specific details are set forth in order to provide an understanding of the claimed subject matter. It may be evident, however, that the claimed subject matter may be practiced without these specific details. In other instances, structures and devices are illustrated in block diagram form in order to facilitate describing the claimed subject matter.

[0019] Many devices provide location-based services that utilize position tracking functionality, such as GPS, that do not provide relatively accurate tracking of positions within enclosures (e.g., building, a multi-level building, a shopping mall, a tunnel, a subway, etc.(e.g., where a GPS signal may be unavailable, blocked, etc.)). Accordingly, as provided herein, a position (e.g., a position of an object, such as a mobile device) may be located within an enclosure, such that a location of the position may be track within an indoor space. For example, a global spatial model may be used to represent locations (e.g., three dimensional locations) of objects utilizing known global coordinates (e.g., GPS receivers mounted on a corner of a building) and/or local coordinates of a local coordinate system associated with the enclosure (e.g., a Cartesian coordinate system). The global spatial model may transform between global coordinates and local coordinates in order to identify the position within the enclosure. In one example, the global spatial model may utilize a blueprint image of the enclosure in order to determine the position within the enclosure. In this way, location tracking may be provided within indoor spaces, and location tracking may be seamlessly transitioned between indoor and outdoor spaces.

[0020] One embodiment of locating a position within an enclosure is illustrated by exemplary method 100 in Fig. 1. It may be appreciated that method 100 may be described in conjunction with example 300 of Fig. 3 for illustrative purposes (e.g., example 300 comprises a representation of an enclosure 302, such as a floor of a building comprising a first GPS device located at an origin point 304 and/or a second GPS device located at a reference point 306 within the enclosure 302). The position within the enclosure may correspond to a position of a given point 308 within the enclosure 302.

[0021] At 102, the method starts. At 104, the origin point 304 for a local coordinate system (e.g., a Cartesian coordinate system comprising a first axis 314 and a second axis

316) associated with the enclosure 302 may be established based upon origin point global coordinates of a global coordinate system for the origin point 304 (e.g., the first GPS device located at the origin point 304 may provide the origin point global coordinates). At 106, the reference point 306 may be established in the local coordinate system based upon reference point global coordinates of the global coordinate system for the reference point 306 (e.g., the second GPS device located at the reference point 306 may provide the reference point global coordinates).

[0022] A directional reference line 318 may be identified within the enclosure 302 (e.g., the first GPS device may provide a true north measurement that may be used to construct the directional reference line 318). At 108, an azimuth gamma 322 (e.g., an angle between the directional reference line 318 and the first axis 314) may be determined based upon the origin 304 and/or the reference point 306. In one example of determining the azimuth gamma 322, an azimuth beta 326 (e.g., an angle from the directional reference line 318 to a reference point line 310 that connects the origin point 304 to the reference point 306) may be determined based upon the origin point 304, the reference point 306, and/or a reference point line length of the reference point line 310. For example, an inverse geodetic problem solution (e.g., an inverse chord equation) may be used to determine the azimuth beta 326. An angle delta 328 from the first axis 314 to the reference point line 310 may be determined. In this way, the azimuth gamma 322 may be determined based upon the azimuth beta 326 and/or the angle delta 328 (e.g., azimuth gamma 322 equals azimuth beta 326 minus angle delta 328).

[0023] At 110, an azimuth alpha 320 (e.g., an angle from the directional reference line 318 to a given point line 312 that connects the origin point 304 to the given point 308) may be determined. In one example of determining the azimuth alpha 320, an angle theta 324 (e.g., an angle between the first axis 314 and the given point line 312) may be determined based upon given point local coordinates of the local coordinate system for the given point 308. In this way, the azimuth alpha 320 may be determined based upon the angle theta 324 and/or the azimuth gamma 322.

[0024] At 112, given point global coordinates (e.g., GPS coordinates of the given point 308, such as latitude and longitude values) of the global coordinate system may be determined for the given point 308 as the position within the enclosure. The given point global coordinates may be determined based upon the azimuth alpha 320, and/or a given point line length of the given point line 312 (e.g., a distance from the origin 304 to the given point 308). For example, a direct geodetic problem solution may be used to

determine the given point global coordinates. In this way, global coordinates, such as GPS coordinates, may be determined for the given point 308 based upon local coordinates of the given point 308 (e.g., the given point local coordinates used to determine the azimuth alpha 320). In one example, the given point 308 may correspond to an object, such as a mobile device. The position of the object may be displayed within a digital representation of the enclosure 302 through a user interface (e.g., a mapping application) on the mobile device and/or on another device, etc., for example. In this way, the mobile device may be tracked inside the enclosure 302 (e.g., by translating local coordinates to global coordinates, such as GPS coordinates). It may be appreciated that the given point 308 may correspond to any object, such as a wireless access point, a person, a location tracking enabled device, etc.). At 114, the method ends.

[0025] One embodiment of locating a position within an enclosure is illustrated by exemplary method 200 in Fig. 2. It may be appreciated that method 200 may be described in conjunction with example 300 of Fig. 3 for illustrative purposes (e.g., example 300 comprises a representation of an enclosure 302, such as a floor of a building comprising a first GPS device located at an origin point 304 and/or a second GPS device located at a reference point 306 within the enclosure 302). The position within the enclosure may correspond to a position of a given point 308 within the enclosure 302.

[0026] At 202, the method starts. At 204, origin point global coordinates of a global coordinate system (e.g., the first GPS device located at the origin point 304 may provide the origin point global coordinates) and origin point local coordinates of a local coordinate system (e.g., a Cartesian coordinate system comprising a first axis 314 and a second axis 316) may be obtained for the origin point 304. At 206, reference point global coordinates of the global coordinate system (e.g., the second GPS device located at the reference point 306 may provide the reference point global coordinates) and reference point local coordinates of the local coordinate system may be obtained for the reference point 306.

[0027] A directional reference line 318 may be identified within the enclosure 302 (e.g., the first GPS device may provide a true north measurement that may be used to construct the directional reference line 318). At 208, an azimuth gamma 322 (e.g., an angle from the directional reference line 318 to the first axis 314 of the local coordinate system) may be determined based upon the origin point 304 and/or the reference point 306. In one example, given point global coordinates of the global coordinate system may be obtained, which may be used to determine one or more angles, such as an azimuth alpha 320 (e.g., the given point global coordinates may be used to identify a given point line length of the

given point line 312, which may be used to determine the azimuth alpha 320). Accordingly, at 210, the azimuth alpha 320 (e.g., an angle from the directional reference line 318 to the given point line 312 connecting the origin point 304 and the given point 308) and the length of given point line 312 may be determined. For example, an inverse geodetic problem solution (e.g., an inverse chord equation) may be used to determine the azimuth alpha 320 and length of given point line 312.

[0028] At 212, an angle theta 324 from the first axis 314 to the given point line 312 may be determined based upon the azimuth gamma 322 and/or the azimuth alpha 320 (e.g., angle theta 324 equals azimuth alpha 320 minus azimuth gamma 322).

[0029] At 214, given point local coordinates of the local coordinate system (e.g., x/y coordinates) may be determined for the given point 308 as the position within the enclosure 302. The given point local coordinates may be determined based upon the angle theta and/or the given point line length of the given point line 312. In this way, local coordinates, such as x/y coordinates, may be determined for the given point 308 based upon global coordinates associated with the enclosure 302, for example. At 216, the method ends.

[0030] Fig. 4 illustrates an example of a system 400 configured for generating one or more circles used for locating a position within an enclosure. The system 400 may comprise a coordinate transfer component 402. The coordinate transfer component 402 may be configured to obtain a blueprint image 404 (e.g., blueprint image processing 406) of a level of an enclosure (e.g., a floor of a building). The blueprint image 404 may comprise one or more pixels that represent the enclosure (e.g., a first room 426, a second room 424, a first wall 414, a second wall 416, a third wall 428, a fourth wall 430, a fifth wall 432, and/or other structures.

[0031] The coordinate transfer component 402 may be configured to determine a set of scale parameters 408 for the blueprint image 404. Because the blueprint image 404 represents the enclosure as pixels, the set of scale parameters 408 may comprise mappings of pixels to physical coordinate measurements of the enclosure. In this way, the set of scale parameters 408 may be used by the coordinate transfer component 402 to switch between pixel values and physical coordinates of the enclosure.

[0032] The coordinate transfer component 402 may be configured to determine a first perpendicular distance 434 from a position 422 within the enclosure to a first structure (e.g., the first wall 414), and a second perpendicular distance 436 from the position 422 to a second structure (e.g., the second wall 416). In this way, the coordinate transfer

component 402 may create perpendicular distances 410. In one example, the first perpendicular distance 434 and/or the second perpendicular distance 436 may be received through a mapping user interface (e.g., a user of a mobile device, corresponding to position 422, may utilize the mobile device to detect and/or input the perpendicular distances).

[0033] The coordinate transfer component 402 may be configured to generate a first circle 418 based upon the first perpendicular distance 434 using the set of scale parameters 408. For example, a first radius may be defined for the first circle 418 based upon the first perpendicular distance 434. The set of scale parameters 408 may be used to transform pixel values to physical coordinates when generating the first circle 418. The coordinate transfer component 402 may be configured to generate a second circle 420 based upon the second perpendicular distance 436 using the set of scale parameters 408. For example, a second radius may be defined for the second circle 420 based upon the second perpendicular distance 436. The set of scale parameters 408 may be used to transform pixel values to physical coordinates when generating the second circle 420. In this way, the coordinate transfer component 402 may be configured to generate the first circle 418 and/or the second circle 420, which may be used to locate a position (e.g., local coordinates of a local coordinate system for the position 422) within the enclosure represented by the blueprint image 404 (e.g., as illustrated in Fig. 5).

[0034] Fig. 5 illustrates an example of a system 500 configured for locating a position within an enclosure. It may be appreciated that in one example, a blueprint image 504 may corresponds to the blueprint image 404 of Fig. 4 (e.g., a coordinate transfer component 402 may have generated a first circle 418, corresponding to a first circle 512, and/or a second circle 420, corresponding to a second circle 514). The system 500 may comprise a coordinate transfer component 502. The coordinate transfer component 502 may have obtained access to the blueprint image 504 and/or may have generated the first circle 512 and/or the second circle 514 within the blueprint image 504.

[0035] The coordinate transfer component 502 may be configured to position 506 the first circle 512 and/or the second circle 514 within the blueprint image 504. For example, the coordinate transfer component 502 may define a first location for the first circle 512, such that the first circle 512 is tangential to a first structure (e.g., a first wall 508). The coordinate transfer component 502 may define a second location for the second circle 514, such that the second circle 514 is tangential to a second structure (e.g., the second wall 510). In this way, the coordinate transfer component 502 may determine coordinates

points of a position (e.g., local coordinates of a local coordinate system for position 422 of Fig. 4) within the enclosure based upon coordinates of the first circle 512 and/or coordinates of the second circle 514 (e.g., pixel coordinates or local coordinates of a local coordinate system for the position). For example, the coordinate points may be based upon center values of the first circle 512 and/or the second circle 514. In one example, the coordinate transfer component 502 may display the coordinate points through a mapping user interface. It may be appreciated that the position may correspond to a floor of a building, such that the coordinate points may correspond to three-dimensional coordinates. In this way, the position may be tracked between floors of the building and/or between an outdoor space and the building, for example.

[0036] Still another embodiment involves a computer-readable medium comprising processor-executable instructions configured to implement one or more of the techniques presented herein. An exemplary computer-readable medium that may be devised in these ways is illustrated in Fig. 6, wherein the implementation 600 comprises a computer-readable medium 616 (e.g., a CD-R, DVD-R, or a platter of a hard disk drive), on which is encoded computer-readable data 614. This computer-readable data 614 in turn comprises a set of computer instructions 612 configured to operate according to one or more of the principles set forth herein. In one such embodiment 600, the processor-executable computer instructions 612 may be configured to perform a method 610, such as at least some of the exemplary method 100 of Fig. 1 and/or at least some of exemplary method 200 of Fig. 2, for example. In another such embodiment, the processor-executable instructions 612 may be configured to implement a system, such as, at least some of the exemplary system 400 of Fig. 4 and/or at least some of the exemplary system 500 of Fig. 5, for example. Many such computer-readable media may be devised by those of ordinary skill in the art that are configured to operate in accordance with the techniques presented herein.

[0037] Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

[0038] As used in this application, the terms "component," "module," "system", "interface", and the like are generally intended to refer to a computer-related entity, either hardware, a combination of hardware and software, software, or software in execution.

For example, a component may be, but is not limited to being, a process running on a processor, a processor, an object, an executable, a thread of execution, a program, and/or a computer. By way of illustration, both an application running on a controller and the controller can be a component. One or more components may reside within a process and/or thread of execution and a component may be localized on one computer and/or distributed between two or more computers.

[0039] Furthermore, the claimed subject matter may be implemented as a method, apparatus, or article of manufacture using standard programming and/or engineering techniques to produce software, firmware, hardware, or any combination thereof to control a computer to implement the disclosed subject matter. The term "article of manufacture" as used herein is intended to encompass a computer program accessible from any computer-readable device, carrier, or media. Of course, those skilled in the art will recognize many modifications may be made to this configuration without departing from the scope or spirit of the claimed subject matter.

[0040] Fig. 7 and the following discussion provide a brief, general description of a suitable computing environment to implement embodiments of one or more of the provisions set forth herein. The operating environment of Fig. 7 is only one example of a suitable operating environment and is not intended to suggest any limitation as to the scope of use or functionality of the operating environment. Example computing devices include, but are not limited to, personal computers, server computers, hand-held or laptop devices, mobile devices (such as mobile phones, Personal Digital Assistants (PDAs), media players, and the like), multiprocessor systems, consumer electronics, mini computers, mainframe computers, distributed computing environments that include any of the above systems or devices, and the like.

[0041] Although not required, embodiments are described in the general context of "computer readable instructions" being executed by one or more computing devices. Computer readable instructions may be distributed via computer readable media (discussed below). Computer readable instructions may be implemented as program modules, such as functions, objects, Application Programming Interfaces (APIs), data structures, and the like, that perform particular tasks or implement particular abstract data types. Typically, the functionality of the computer readable instructions may be combined or distributed as desired in various environments.

[0042] Fig. 7 illustrates an example of a system 710 comprising a computing device 712 configured to implement one or more embodiments provided herein. In one configuration,

computing device 712 includes at least one processing unit 716 and memory 718. Depending on the exact configuration and type of computing device, memory 718 may be volatile (such as RAM, for example), non-volatile (such as ROM, flash memory, etc., for example) or some combination of the two. This configuration is illustrated in Fig. 7 by dashed line 714.

[0043] In other embodiments, device 712 may include additional features and/or functionality. For example, device 712 may also include additional storage (e.g., removable and/or non-removable) including, but not limited to, magnetic storage, optical storage, and the like. Such additional storage is illustrated in Fig. 7 by storage 720. In one embodiment, computer readable instructions to implement one or more embodiments provided herein may be in storage 720. Storage 720 may also store other computer readable instructions to implement an operating system, an application program, and the like. Computer readable instructions may be loaded in memory 718 for execution by processing unit 716, for example.

[0044] The term "computer readable media" as used herein includes computer storage media. Computer storage media includes volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information such as computer readable instructions or other data. Memory 718 and storage 720 are examples of computer storage media. Computer storage media includes, but is not limited to, RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, Digital Versatile Disks (DVDs) or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information and which can be accessed by device 712. Any such computer storage media may be part of device 712.

[0045] Device 712 may also include communication connection(s) 726 that allows device 712 to communicate with other devices. Communication connection(s) 726 may include, but is not limited to, a modem, a Network Interface Card (NIC), an integrated network interface, a radio frequency transmitter/receiver, an infrared port, a USB connection, or other interfaces for connecting computing device 712 to other computing devices. Communication connection(s) 726 may include a wired connection or a wireless connection. Communication connection(s) 726 may transmit and/or receive communication media.

[0046] The term "computer readable media" may include communication media. Communication media typically embodies computer readable instructions or other data in

a "modulated data signal" such as a carrier wave or other transport mechanism and includes any information delivery media. The term "modulated data signal" may include a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal.

[0047] Device 712 may include input device(s) 724 such as keyboard, mouse, pen, voice input device, touch input device, infrared cameras, video input devices, and/or any other input device. Output device(s) 722 such as one or more displays, speakers, printers, and/or any other output device may also be included in device 712. Input device(s) 724 and output device(s) 722 may be connected to device 712 via a wired connection, wireless connection, or any combination thereof. In one embodiment, an input device or an output device from another computing device may be used as input device(s) 724 or output device(s) 722 for computing device 712.

[0048] Components of computing device 712 may be connected by various interconnects, such as a bus. Such interconnects may include a Peripheral Component Interconnect (PCI), such as PCI Express, a Universal Serial Bus (USB), firewire (IEEE 1394), an optical bus structure, and the like. In another embodiment, components of computing device 712 may be interconnected by a network. For example, memory 718 may be comprised of multiple physical memory units located in different physical locations interconnected by a network.

[0049] Those skilled in the art will realize that storage devices utilized to store computer readable instructions may be distributed across a network. For example, a computing device 730 accessible via a network 728 may store computer readable instructions to implement one or more embodiments provided herein. Computing device 712 may access computing device 730 and download a part or all of the computer readable instructions for execution. Alternatively, computing device 712 may download pieces of the computer readable instructions, as needed, or some instructions may be executed at computing device 712 and some at computing device 730.

[0050] Various operations of embodiments are provided herein. In one embodiment, one or more of the operations described may constitute computer readable instructions stored on one or more computer readable media, which if executed by a computing device, will cause the computing device to perform the operations described. The order in which some or all of the operations are described should not be construed as to imply that these operations are necessarily order dependent. Alternative ordering will be appreciated by

one skilled in the art having the benefit of this description. Further, it will be understood that not all operations are necessarily present in each embodiment provided herein.

[0051] Moreover, the word "exemplary" is used herein to mean serving as an example, instance, or illustration. Any aspect or design described herein as "exemplary" is not necessarily to be construed as advantageous over other aspects or designs. Rather, use of the word exemplary is intended to present concepts in a concrete fashion. As used in this application, the term "or" is intended to mean an inclusive "or" rather than an exclusive "or". That is, unless specified otherwise, or clear from context, "X employs A or B" is intended to mean any of the natural inclusive permutations. That is, if X employs A; X employs B; or X employs both A and B, then "X employs A or B" is satisfied under any of the foregoing instances. In addition, the articles "a" and "an" as used in this application and the appended claims may generally be construed to mean "one or more" unless specified otherwise or clear from context to be directed to a singular form. Also, at least one of A and B and/or the like generally means A or B or both A and B.

[0052] Also, although the disclosure has been shown and described with respect to one or more implementations, equivalent alterations and modifications will occur to others skilled in the art based upon a reading and understanding of this specification and the annexed drawings. The disclosure includes all such modifications and alterations and is limited only by the scope of the following claims. In particular regard to the various functions performed by the above described components (e.g., elements, resources, etc.), the terms used to describe such components are intended to correspond, unless otherwise indicated, to any component which performs the specified function of the described component (*e.g.*, that is functionally equivalent), even though not structurally equivalent to the disclosed structure which performs the function in the herein illustrated exemplary implementations of the disclosure. In addition, while a particular feature of the disclosure may have been disclosed with respect to only one of several implementations, such feature may be combined with one or more other features of the other implementations as may be desired and advantageous for any given or particular application. Furthermore, to the extent that the terms "includes", "having", "has", "with", or variants thereof are used in either the detailed description or the claims, such terms are intended to be inclusive in a manner similar to the term "comprising."

CLAIMS

1. A method for locating a position within an enclosure, comprising:

establishing an origin point for a local coordinate system associated with the enclosure based upon origin point global coordinates of a global coordinate system for the origin point;

establishing a reference point in the local coordinate system based upon reference point global coordinates of the global coordinate system for the reference point;

determining an azimuth gamma from a directional reference line to a first axis of the local coordinate system based upon at least one of the origin point or the reference point;

determining an azimuth alpha from the directional reference line to a given point line connecting the origin point to a given point within the enclosure; and

determining given point global coordinates of the global coordinate system for the given point as a position within the enclosure based upon at least one of the azimuth alpha, a given point line length of the given point line, or the origin point global coordinates.

2. The method of claim 1, the enclosure comprising a building and the position corresponding to a location within the building.

3. The method of claim 1, the determining an azimuth alpha comprising:

determining an angle theta between the first axis and the given point line based upon given point local coordinates of the local coordinate system for the given point; and

determining the azimuth alpha based upon the angle theta and the azimuth gamma.

4. The method of claim 1, the determining an azimuth gamma comprising:

determining an azimuth beta from the directional reference line to a reference point line connecting the origin point to the reference point within the enclosure based upon at least one of the origin point, the reference point, or a reference point line length of the reference point line;

determining an angle delta from the first axis to the reference point line; and

determining the azimuth gamma based upon the azimuth beta and the angle delta.

5. The method of claim 4, the determining an azimuth beta comprising:

utilizing an inverse geodetic problem solution to determine the azimuth beta.

6. The method of claim 1, the determining given point global coordinates comprising:

utilizing a direct geodetic problem solution to determine the given point global coordinates.

7. A system for locating a position within an enclosure, comprising:

a coordinate transfer component configured to:

obtain a blueprint image of a level of an enclosure;

determine a set of scale parameters for the blueprint image, the set of scale parameters comprising mappings of pixels of the blueprint image to physical coordinate measurements of the enclosure;

determine a first perpendicular distance from a position within the enclosure to a first structure and a second perpendicular distance from the position to a second structure;

generate a first circle based upon the first perpendicular distance using the set of scale parameters;

generate a second circle based upon the second perpendicular distance using the set of scaled parameters;

define a first location for the first circle, such that the first circle is tangential to the first structure;

define a second location for the second circle, such that the second circle is tangential to the second structure; and

determine coordinate points of the position within the enclosure based upon coordinates of the first circle and coordinates of the second circle.

8. The system of claim 7, the coordinate transfer component configured to:

receive the first perpendicular distance and the second perpendicular distance through a mapping user interface.

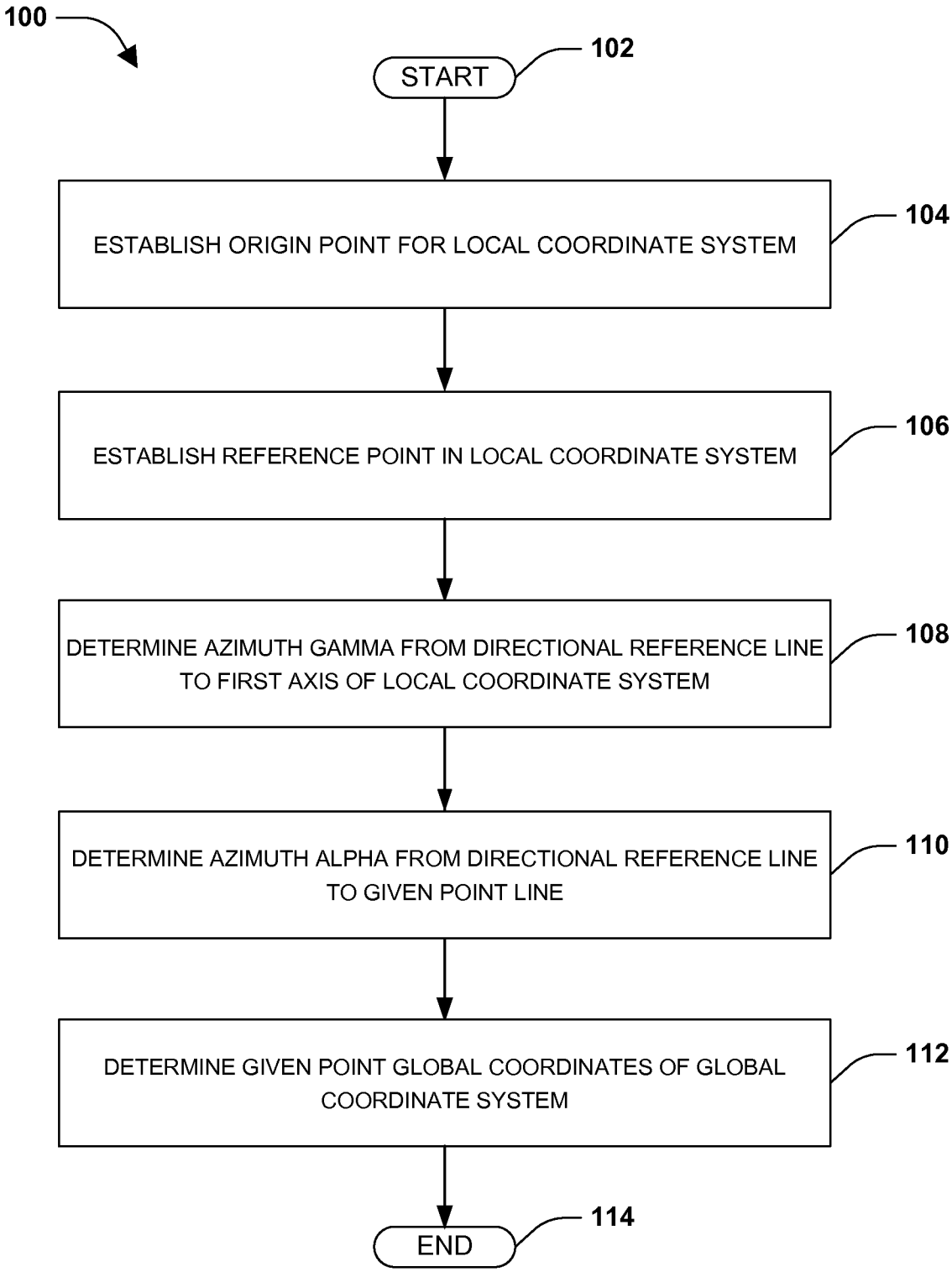
9. The system of claim 8, the coordinate transfer component configured to:

display the coordinate points through the mapping user interface.

10. The system of claim 7, the generating a first circle and the generating a second circle comprising:

defining a first radius for the first circle based upon the first perpendicular distance; and

defining a second radius for the second circle based upon the second perpendicular distance.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START
102
ESTABLISH ORIGIN POINT FOR LOCAL COORDINATE SYSTEM
104
ESTABLISH REFERENCE POINT IN LOCAL COORDINATE SYSTEM
106
DETERMINE AZIMUTH GAMMA FROM DIRECTIONAL REFERENCE LINE TO FIRST AXIS OF LOCAL COORDINATE SYSTEM
108
DETERMINE AZIMUTH ALPHA FROM DIRECTIONAL REFERENCE LINE TO GIVEN POINT LINE
110
DETERMINE GIVEN POINT GLOBAL COORDINATES OF GLOBAL COORDINATE SYSTEM
112
END
114

FIG. 1

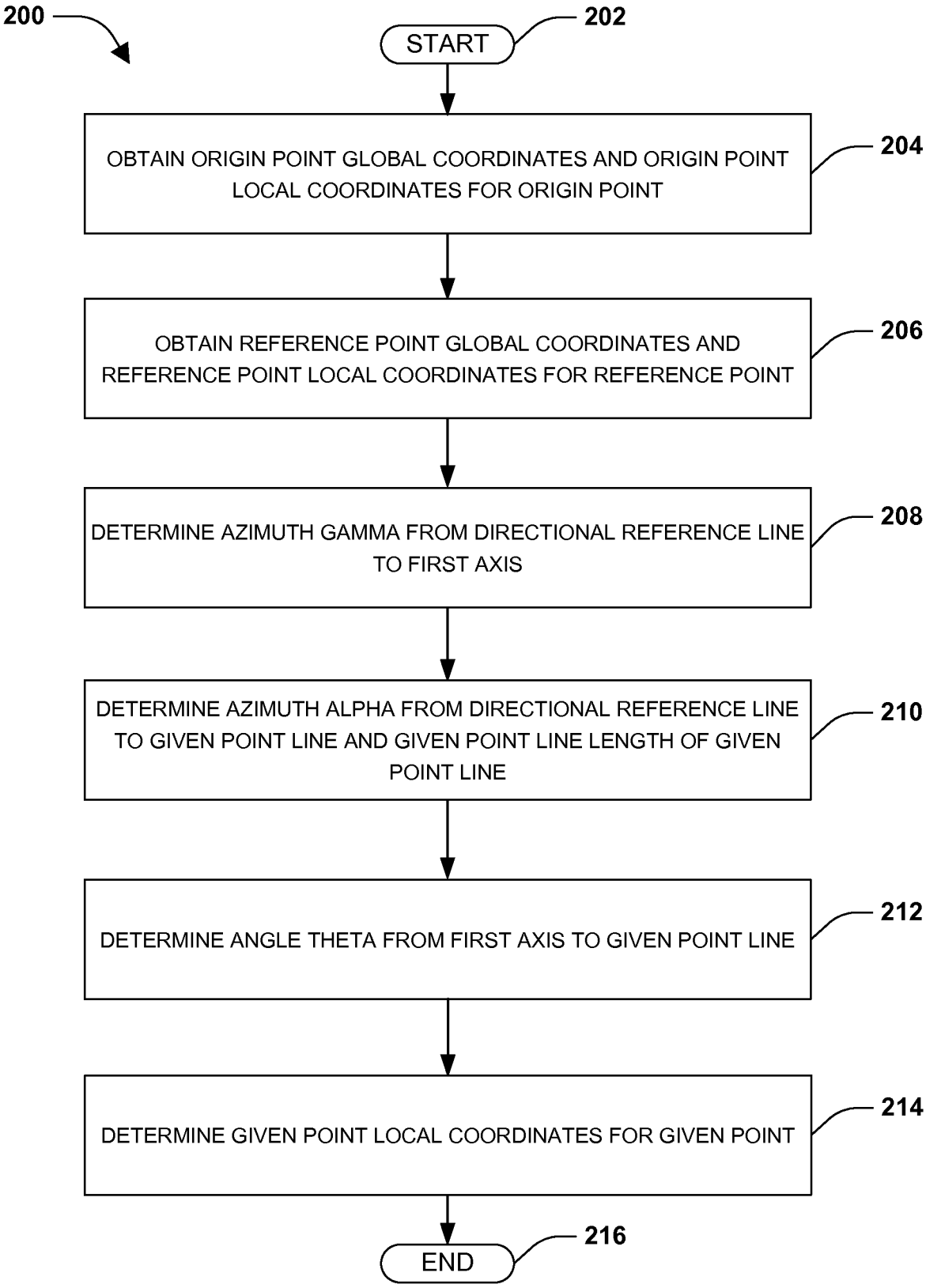
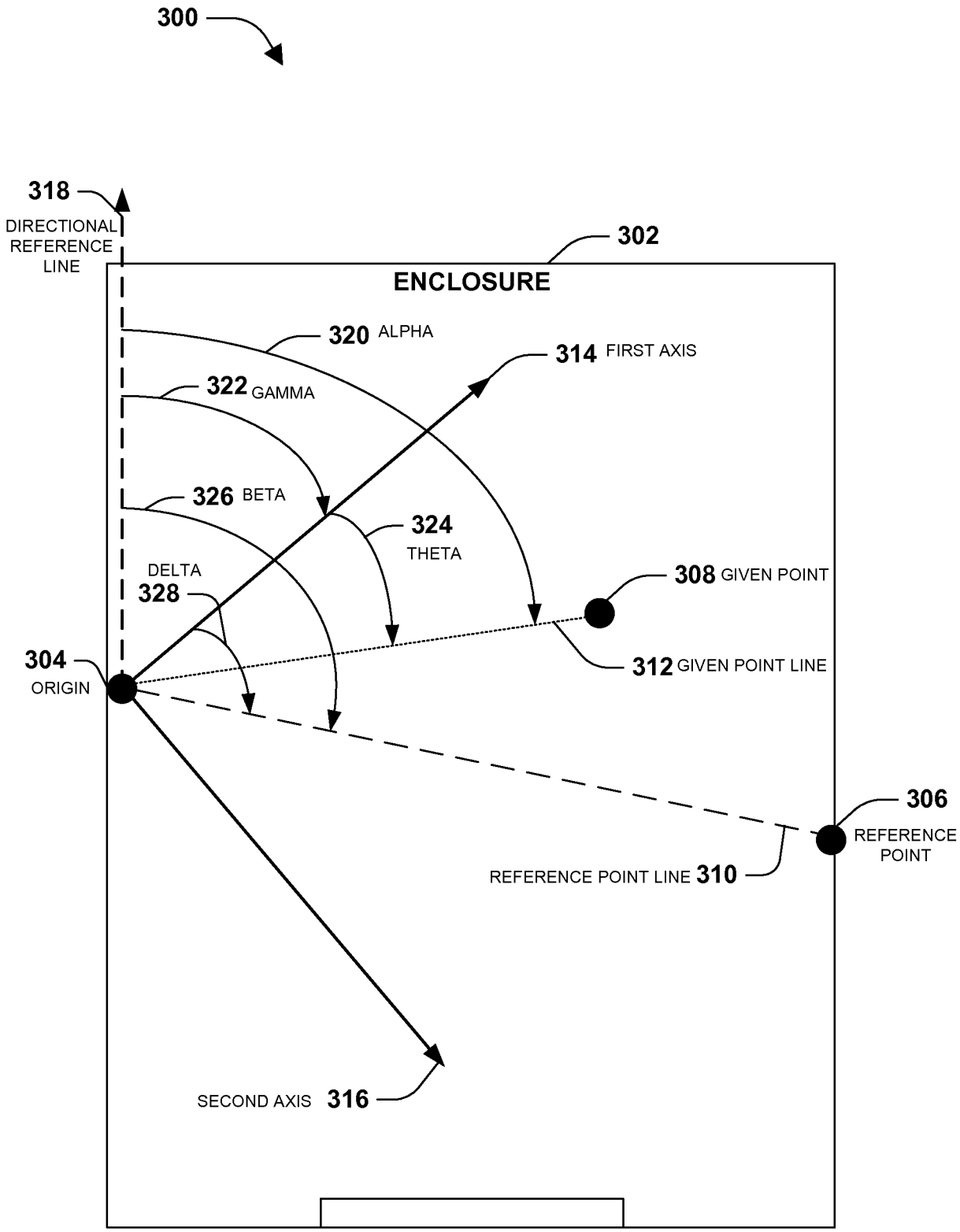

200
START
202
OBTAIN ORIGIN POINT GLOBAL COORDINATES AND ORIGIN POINT LOCAL COORDINATES FOR ORIGIN POINT
204
OBTAIN REFERENCE POINT GLOBAL COORDINATES AND REFERENCE POINT LOCAL COORDINATES FOR REFERENCE POINT
206
DETERMINE AZIMUTH GAMMA FROM DIRECTIONAL REFERENCE LINE TO FIRST AXIS
208
DETERMINE AZIMUTH ALPHA FROM DIRECTIONAL REFERENCE LINE TO GIVEN POINT LINE AND GIVEN POINT LINE LENGTH OF GIVEN POINT LINE
210
DETERMINE ANGLE THETA FROM FIRST AXIS TO GIVEN POINT LINE
212
DETERMINE GIVEN POINT LOCAL COORDINATES FOR GIVEN POINT
214
END
216

FIG. 2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318
DIRECTIONAL REFERENCE LINE
302
ENCLOSURE
320 ALPHA
314 FIRST AXIS
322 GAMMA
326 BETA
324 THETA
DELTA 328
308 GIVEN POINT
304 ORIGIN
312 GIVEN POINT LINE
306
REFERENCE POINT
REFERENCE POINT LINE 310
SECOND AXIS 316

FIG. 3

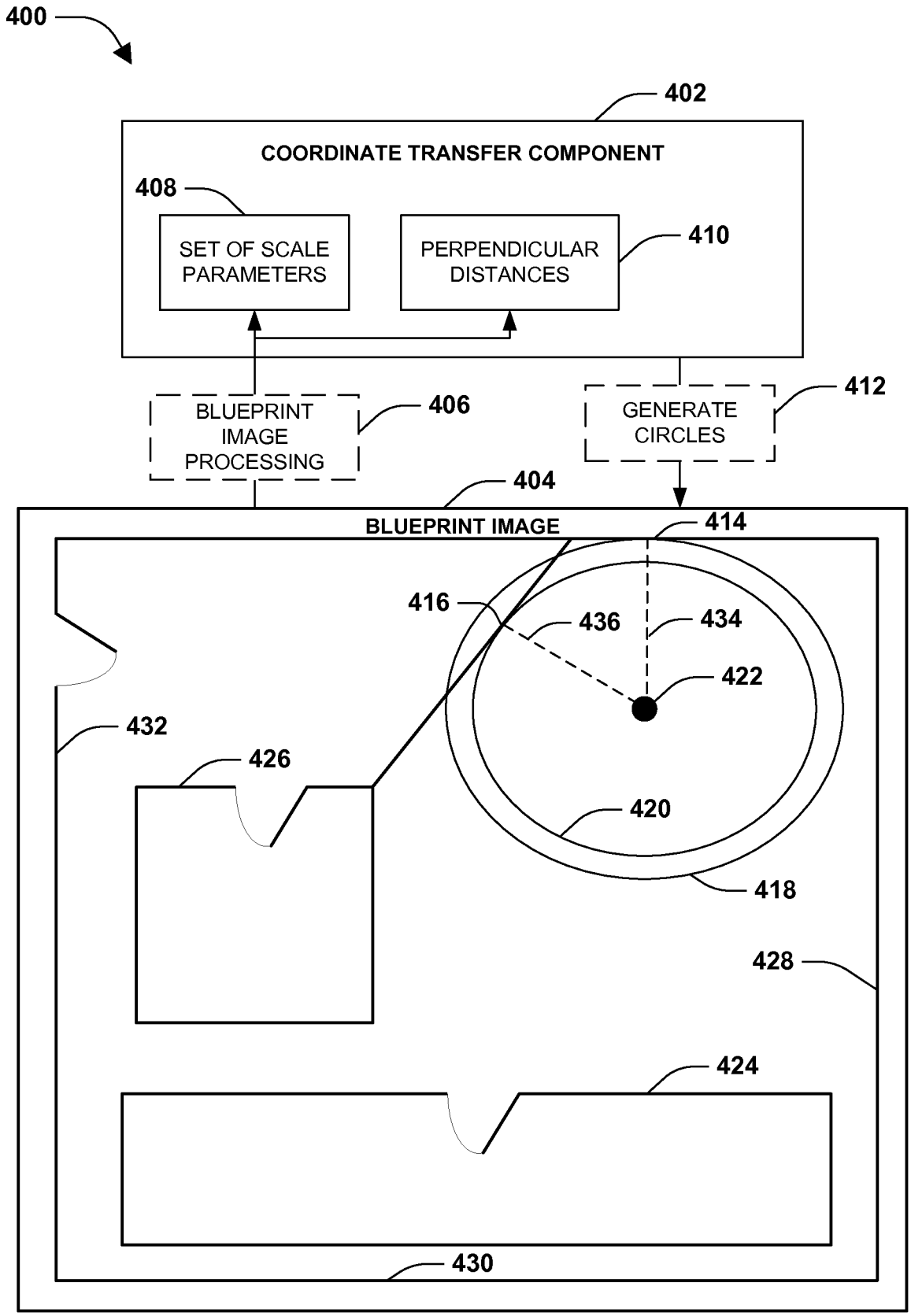
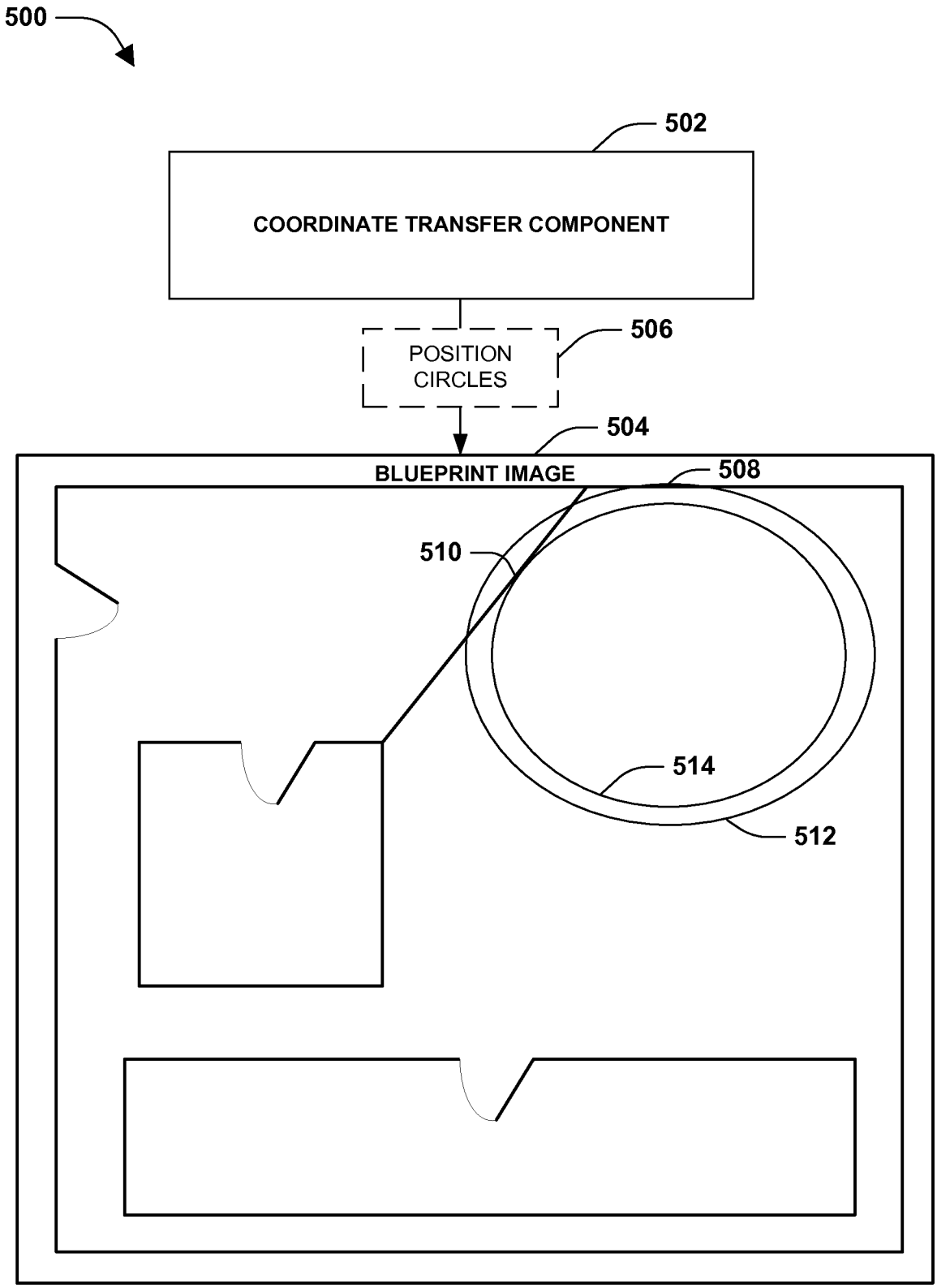

400
402
COORDINATE TRANSFER COMPONENT
408
SET OF SCALE PARAMETERS
PERPENDICULAR DISTANCES
410
BLUEPRINT IMAGE PROCESSING
406
GENERATE CIRCLES
412
404
BLUEPRINT IMAGE
414
416
436
434
422
432
426
420
418
428
424
430

FIG. 4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502
COORDINATE TRANSFER COMPONENT
506
POSITION CIRCLES
504
BLUEPRINT IMAGE
508
510
514
512

FIG. 5

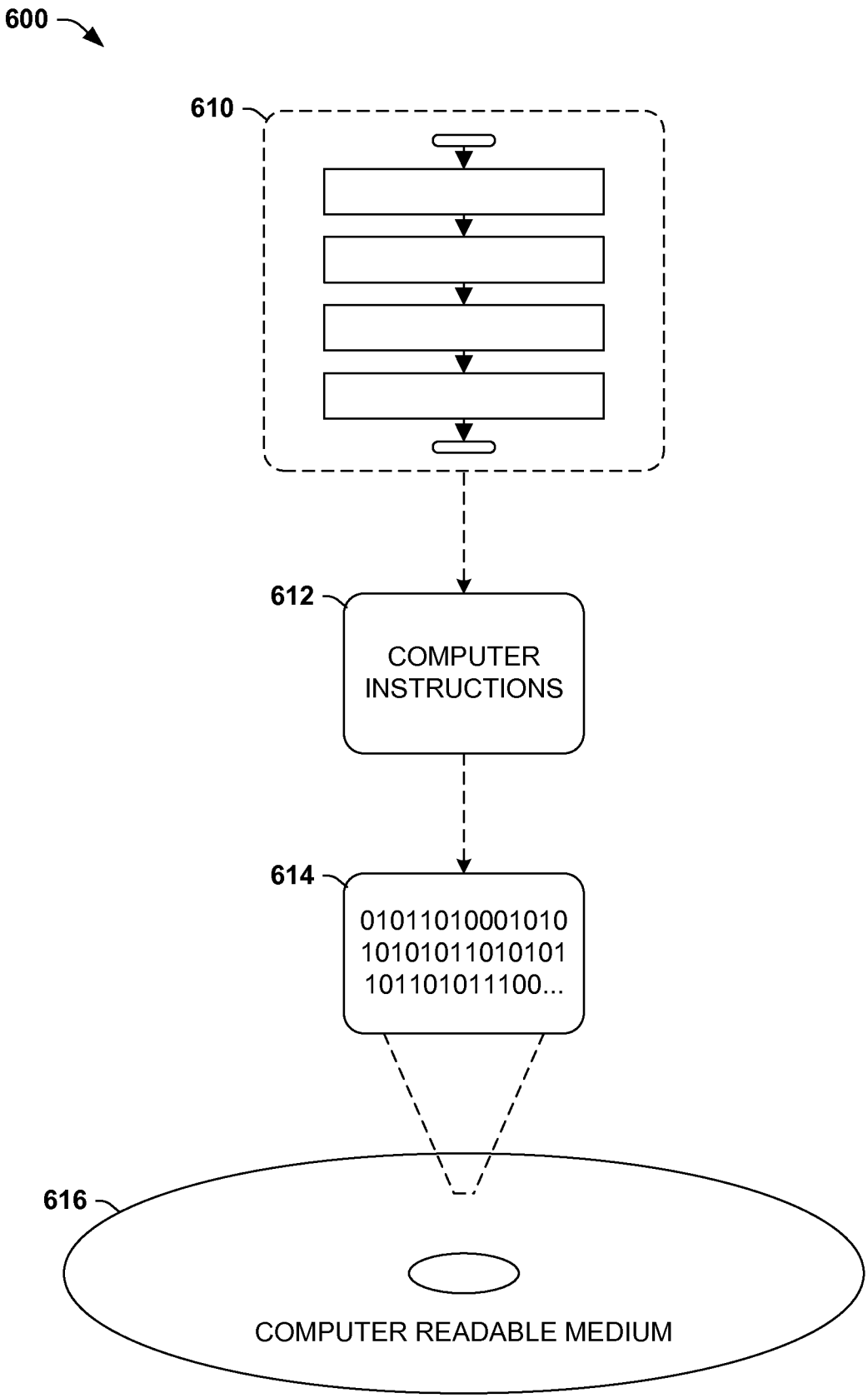
600
610
612
COMPUTER INSTRUCTIONS
614
01011010001010
10101011010101
101101011100...
616
COMPUTER READABLE MEDIUM

FIG. 6

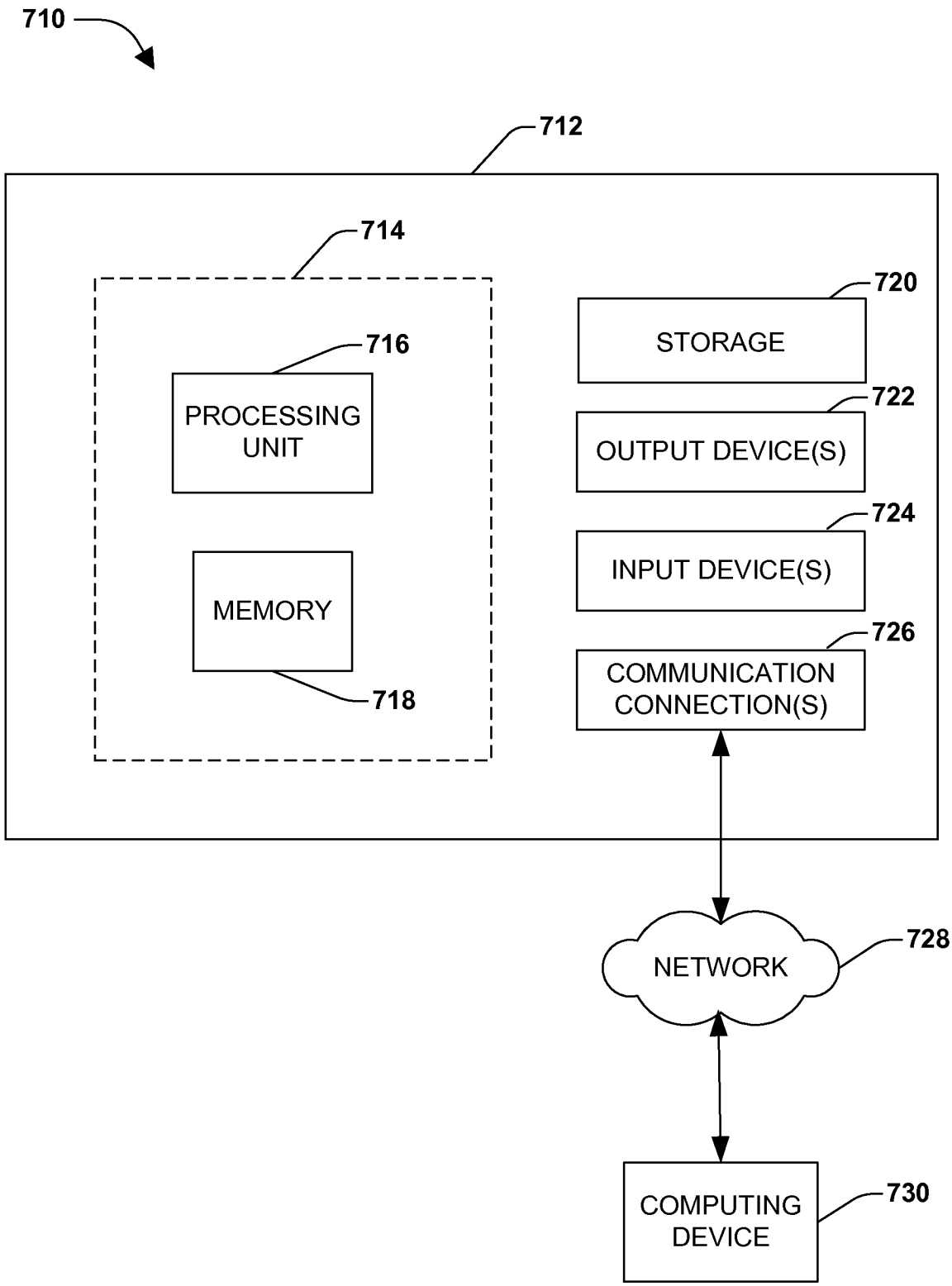
710
712
714
716
PROCESSING UNIT
MEMORY
718
720
STORAGE
722
OUTPUT DEVICE(S)
724
INPUT DEVICE(S)
726
COMMUNICATION CONNECTION(S)
NETWORK
728
COMPUTING DEVICE
730

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/072892

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01S19/48
ADD.

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)
G01S

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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/066559 A1 (JUDELSON DAVID N [US]) 18 March 2010 (2010-03-18) paragraph [0053] - paragraph [0068] paragraph [0082] - paragraph [0083] paragraph [0142] - paragraph [0155] paragraph [0178] - paragraph [0190] claims 16-21 ----- -/--	7-10

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

[X] 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	Date of mailing of the international search report
26 March 2014	03/04/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Ó Donnabháin, C

1

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/072892

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. [X] Claims Nos.: 1-6
because they relate to subject matter not required to be searched by this Authority, namely:

Claims 1-6 refer to a process which consists of a purely mental activity.

2. [X] Claims Nos.: 1-6
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:

see FURTHER INFORMATION sheet PCT/ISA/210

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 an 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

International application No
PCT/US2013/072892

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	HYEJIN KIM ET AL: "Interactive annotation on mobile phones for real and virtual space registration", MIXED AND AUGMENTED REALITY (ISMAR), 2011 10TH IEEE INTERNATIONAL SYMPOSIUM ON, IEEE, [Online] 26 October 2011 (2011-10-26), pages 265-266, XP032114500, DOI: 10.1109/ISMAR.2011.6143894 ISBN: 978-1-4577-2183-0 Retrieved from the Internet: URL:http://www.mathworks.de/matlabcentral/fileexchange/9696-geodetic-transformations-toolbox> [retrieved on 2014-03-19] the whole document -----	7-10

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2013/072892

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010066559 A1	18-03-2010	US 2010066559 A1	18-03-2010
		US 2011176179 A1	21-07-2011

Continuation of Box II.1

Claims Nos.: 1-6

Claims 1-6 refer to a process which consists of a purely mental activity.

Continuation of Box II.2

Claims Nos.: 1-6

Claims 1-6 refer to a process which consists of a purely mental activity, thus not required to be searched according to Rule 39.1 PCT.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guidelines C-IV, 7.2), should the problems which led to the Article 17(2) declaration be overcome.