(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification:
G06Q 50/00 (2006.01)

(21) International Application Number:
PCT/US2009/035164

(22) International Filing Date:
25 February 2009 (25.02.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/032,276   28 February 2008 (28.02.2008)   US
12/323,793   26 November 2008 (26.11.2008)   US

(71) Applicant (for all designated States except US): CHEVRON U.S.A. INC. [US/US]; 6001 Bollinger Canyon Road, San Ramon, California 94583 (US).

(72) Inventor; and

(75) Inventor/Applicant (for US only): RENNER, Kevyn Mark [US/US]; 1432 Crocker Drive, El Dorado Hills, California 95762 (US).

(74) Agents: HADLOCK, Timothy J. et al.; Chevron Corporation, Law Department, Post Office Box 6006, San Ramon, California 94583-0806 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
—   without international search report and to be republished upon receipt of that report (Rule 48.2(g))

(54) Title: METHODS AND SYSTEMS FOR CONDUCTING A MEETING IN A VIRTUAL ENVIRONMENT
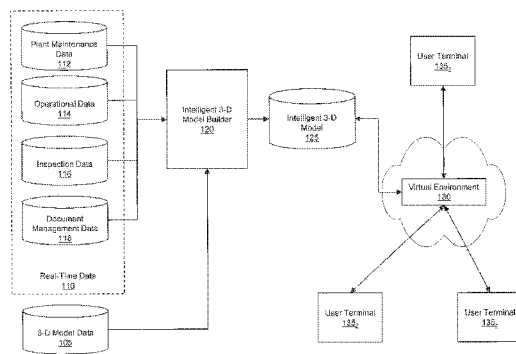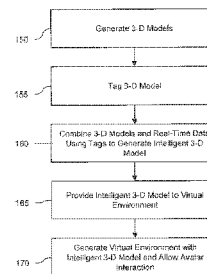

FIGURE 1A

FIGURE 1B

(57) Abstract: Systems and methods of conducting a meeting between a plurality of people in a virtual environment are provided. A display associated with each of the plurality of people outputs a virtual conference room that includes an avatar associated with each of the plurality of people, and a virtual display that displays a 3-D model of a manufacturing facility. A selection of an object of the 3-D model is received and the virtual display displays information associated with the selected object of the 3-D model. The display associated with each of the plurality of people outputs the virtual conference room and the virtual display with the information associated with the selected object of the 3-D model.

METHODS AND SYSTEMS FOR CONDUCTING A MEETING IN A VIRTUAL ENVIRONMENT

CROSS-REFERENCE TO RELATED APPLICATIONS

5

The present application claims priority under 35 U.S.C. § 119, to U.S. Provisional Application No. 61/032,276, filed February 28, 2008, the entire disclosure of which is herein expressly incorporated by reference.

10   ## FIELD OF INVENTION

The present invention relates to a method and system for conducting a meeting in a virtual environment, in particular, for use in improved manufacturing facility and asset operation, maintenance, and training.

15

BACKGROUND OF THE INVENTION

Today a manufacturing business enterprise may have operations, experts, and facilities spread across the globe. Getting all the appropriate personnel in
20   one place at one time for training, knowledge sharing, or troubleshooting is difficult, expensive, and often not timely enough to address an urgent issue. Teleconferences or even web-conferences, however, provide only limited participant interaction and do not provide a true visual reference to the plant equipment that is the subject of the discussion. Also, taking expensive
25   manufacturing equipment off line for training and maintenance purposes is expensive and disruptive to the manufacturing process. Longer off-line times occur for repairs or maintenance when work crews do not have sufficient advance training. Furthermore, the more time spent by personnel in a live plant increases the risk of injury to such personnel.

30

SUMMARY OF THE INVENTION

In view of the above-identified and other deficiencies of conventional methods and systems, it has been recognized that real-time, real-asset data is needed in association with manufacturing facility assets in order to have meaningful

5   computer-based training or management of operations. Accordingly, it would be useful to have a method and system for addressing the above-described needs and overcoming shortcomings in any existing systems.

Systems and methods of conducting a meeting between a plurality of people in a virtual environment are provided. An exemplary method involves outputting, on a display associated with each of the plurality of people, a virtual conference room that includes an avatar associated with each of the plurality of people and a virtual display that displays a 3-D model of a manufacturing facility. A selection of an object of the 3-D model is received and the virtual display displays information associated with the selected object of the 3-D model. The display associated with each of the plurality of people outputs the virtual conference room and the virtual display with the information associated with the selected object of the 3-D model.

The information associated with the object may provide a source for collaborative updating, editing and training on the execution of typical operating and maintenance work processes.

When the manufacturing facility is an oil refinery, the selected object can be one of a vessel, rotating machinery, separation equipment and vessels,

10   mixing equipment and vessels, reaction equipment and vessels, associated values, piping, instrumentation and/or other structures.

The information associated with the selected object can be, for example, maintenance data, operational data, inspection data or a document associated with the selected object. Alternatively, or additionally, the

15   information associated with the selected object is a plurality of sub-objects.

The method also involves receiving a selection of one of the sub-objects and displaying on the virtual display information associated with the selected sub-object of the 3-D model. The display associated with each of the plurality of people outputs the virtual conference room and the virtual display with the

5   information associated with the selected sub-object of the 3-D model.

The information associated with the selected sub-object can be, for example, maintenance data, operational data, inspection data or a document associated with the selected object.

The method can also involve updating the 3-D model of the manufacturing

10   facility using real-time data. The real-time data can be, for example, maintenance data, operational data, inspection data or a document.

An exemplary system includes a server that executes a computer program to produce a virtual environment that includes a virtual conference room and a plurality of user terminals, associated with each of the plurality of people

15   coupled to the server by a network. The system can also include a manufacturing facility information storage coupled to the server. The server includes display logic to provide an output of the virtual conference room to a display associated with each of the plurality of user terminals, the virtual conference room including an avatar associated with each of the plurality of

20   people, and a virtual display that displays a 3-D model of a manufacturing facility. The server includes selection logic that receives a selection of an object of the 3-D model, and in response to the selection the display logic provides an output to the display associated with each of the plurality of people with the virtual display with the information associated with the selected object

25   of the 3-D model.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1A is a block diagram of an exemplary system in accordance with the present invention.

5   Figure 1B is a flow diagram of an exemplary method in accordance with the present invention.

Figure 2 is a block diagram of an exemplary server that executes a computer program to produce a virtual environment in accordance with the present invention.

10   Figures 3A-3D is a block diagram illustrating an exemplary virtual conference room in accordance with the present invention.

Figure 4 is a flow diagram of another exemplary method in accordance with the present invention.

15   ## DETAILED DESCRIPTION OF PREFERRED
EMBODIMENTS OF THE INVENTION

Figure 1A is a block diagram of an exemplary system in accordance with the present invention. The system includes a plurality of user terminals 135_1-135_n

20   coupled to virtual environment 130. User terminals 135_1-135_n can be any type of user terminal, including, but not limited to, desktop computers, laptop computers, personal digital assistants (PDAs), wireless telephones, smart phones and/or the like. As will be described in more detail below in connection with Figure 2, virtual environment 130 is executed on a server.

25

An intelligent, location accurate, 3-D model of a manufacturing facility 125 is also coupled to virtual environment 130. Intelligent 3-D model 125 is coupled to intelligent 3-D model builder 120, which in turn is coupled to 3-D model data database 105, and real-time data databases 110. Real-time data

30   databases include plant maintenance data database 112, operational data database 114, inspection data database 116 and document management system data database 118. Other types of real-time data can be employed in addition to, or as an alternative to, those illustrated in Figure 1A. One or more

of the elements of Figure 1A can be coupled to each other by way of any type of network, such as, for example, the Internet.

Overall operation of the system will now be described in connection with the

5   flow diagram of Figure 1B. Initially, one or more location accurate 3-D models of a manufacturing facility are generated and populated into database 105 (step 150). The 3-D models can be generated using, for example, laser scanning techniques, such as those provided by INOVx of Irvine California. Alternatively, or additionally, the object models can be created by conversion

10   of 2-D or 3-D computer-aided design (CAD) files. The 3-D models can be designed with any desired tolerance, such as five millimeters. Thus, for example, although a piping is designed to be perfectly vertical, the 3-D model can reflect any variance in the horizontal direction.

15   Various elements of the 3-D models that will be updated with real-time data are tagged (step 155). These elements can be any elements, such as objects, sub-objects, components, structures, circuits, sub-system and/or the like. Intelligent 3-D model builder 120 then uses the tags to combine the 3-D model data with real-time data to generate an intelligent 3-D model (step 160).

20   The 3-D model is "intelligent" in that it is based on both structural and operational information, and it is also updated based on real-time data. The intelligent 3-D model is stored in database 125, which provides the model to virtual environment 130 (step 165). As will be described in more detail below, the virtual environment 130 generated using the 3-D model allows interaction

25   between the model and avatars representing users of terminals 135_1-135_n (step 170). Although not illustrated, the 3-D model itself can be updated to reflect structural changes, such as new elements, rearrangement of elements, etc.

30   Now that an overview of the generation of the virtual environment has been provided, a description of the operation of the virtual environment will be described in connection with Figures 2-4. Figure 2 is a block diagram of an exemplary server that executes a computer program to produce a virtual

environment in accordance with the present invention. The server 250 includes a network interface 255 to exchange information with user terminals 135_1-135_n and with intelligent 3-D model database 125. Network interface 255 is coupled to processor 260, which in turn is coupled to memory 270.

5   Processor 260 includes logic 262-268, which will be described in more detail below. Processor 260 can be any type of processor including a microprocessor, field programmable gate array (FPGA), application specific integrated circuit (ASIC) and/or the like. When the processor is a microprocessor, logic 262-268 can be processor-executable code loaded from

10   memory 270.

Turning now to Figures 3A and 4, logic 262 initially displays a virtual environment that includes avatars 305_1-305_n, and virtual display 310 that includes an intelligent 3-D model comprising 3-D objects 315_1-315_n (step 405). Depending upon the type of manufacturing facility represented by the

15   intelligent 3-D model, the objects can be, for example, one of a vessel, rotating machinery, separation equipment and vessels, mixing equipment and vessels, reaction equipment and vessels, associated valves, piping, instrumentation elements and/or other structures. The virtual display can also display additional information, such as, for example, object maintenance data.

20   Although Figure 3A illustrates a particular number of avatars and a particular number of objects comprising the 3-D model, the present invention can be employed with greater or fewer numbers of avatars and/or objects comprising the 3-D model. Furthermore, the arrangement of the objects of the 3-D model is merely exemplary and the objects can be arranged in a different manner.

25   Additionally, the present invention can also be employed with more than one display. Although not illustrated, the virtual environment can include more than one virtual conference room and/or virtual display. Furthermore, the virtual conference room can include a virtual whiteboard, as well as elements for capturing avatar notes and comments, such as flip charts, attached text or

30   audio comments and/or the like.

Logic 264 then determines whether server 250 has received an avatar or 3-D model updates (step 410). Avatar updates can include the addition or removal of avatars due to user terminals or sessions joining or leaving the virtual environment and/or movement of avatars within the virtual

5   environment. 3-D model updates can include updates based on real-time data 110. When logic 264 determines that such updates have been received ("Yes" path out of decision step 410), then logic 264 updates the virtual environment (step 415), and logic 262 displays the virtual environment with the updated information (step 405).

10

When avatar or 3-D model updates have not been received ("No" path out of decision step 410), then logic 266 determines whether a 3-D object selection has been received (step 420). A 3-D object selection can be performed using an input device at one of the user terminals 135_1-135_n, movement of an avatar

15   within the virtual environment to select the object and/or the like. The input device can be any type of input device including, but not limited to, a keyboard, keypad, mouse, pen input device, trackpad, trackball and/or the like. When an object selection has not been received ("No" path out of decision step 420), then logic 262 continues to display the virtual environment

20   (step 405).

When, however, an object selection is received ("Yes" path out of decision step 420), then logic 268 determines whether the selection is to display information about the selected object or to display sub-objects of the selected object (step 425). The information can be, for example, maintenance data,

25   operational data, inspection data or a document associated with the selected object. When logic 268 determines that the selection is to display information about the selected object ("No" path out of decision step 425), then, as illustrated in Figure 3B, logic 262 displays the object information on display 210 (step 430). Users can interact with the data using an input device of the

30   user terminal and/or avatars until one of the user's requests that display 210 be returned to the state where it displays the 3-D model comprising the 3-D objects ("Yes" path out of decision step 435).

When the object selection is to display the sub-objects of the selected object ("Yes" path out of decision step 425), then, as illustrated in Figure 3C, logic 262 displays the 3-D sub-objects 325_1-325_n (step 440). When a sub-object

5   selection is received ("Yes" path out of decision step 445), then, as illustrated in Figure 3D, logic 262 displays the sub-object information within the virtual environment (step 450) until logic 262 receives a request from one of the users and/or avatars to return to the sub-object display ("Yes" path out of decision step 455) or to return to the object display ("Yes" path out of decision

10 step 460).

Although the Figures above illustrate particular information being included on the displays, the present invention is not so limited. For example, the displays can provide "knowledge views" that combine various views for added

15 perspective. For example, structural steel and piping views can be combined so that proper access and routing can be planned and communicated to turnaround staff. Scaffolding plans can be laid over the views to ensure suitability. Similarly, the present invention provides the ability to subtract views to provide a better understanding of a particular environment. The

20 views, including the knowledge views, can be panned, zoomed and otherwise navigated to gain a full perspective.

The present invention can also provide a querying capability. Thus, for example, a query for all pipes containing sour gas and having a corrosion rate

25 greater than 4 mils/annum and an operating temperature greater than 500 degrees can be performed to produce an intelligent 3-D model of such pipes. This would involve pulling data from the various databases to identify such pipes.

30 In addition, the present invention can provide a simulation and playback capability to create move-like depictions of scenarios and events, which would support training, learning and reviews of upsets and recovery processes. This capability can also include the ability to add annotations that persist in the

context for developing procedures and advancing best practices among the viewers of the depictions.

5 The present invention can be used in a variety of contexts. For example, if an upgrade project is planned for motor operated valves, power lines, power poles and junction boxes feeding the valves can easily be located and identified. The present invention can also be employed for determining optimal lineups, sequencing of actions, back flushing volumes, etc. Similarly, the intelligent 3-D models allow inspects to determine scaffolding needs,
10 access limitations and safety requirements prior to visiting the actual physical plant. The databases can also include information about dynamic assets, such as cranes, that may be temporarily deployed at a plant.

An exemplary use of the present invention can be for repairs. Accordingly,
15 the intelligent 3-D model can be coupled with a temporary repair database in order to determine all opportunities for permanent repair within the boundaries of any turnaround activity or work order involving a shut down. This can involve the querying capability discussed above. Furthermore, work orders can be precisely linked to the target equipment or systems to provide the most
20 current asset. The present invention also allows for the work orders to be linked with the necessary scheduled support, such as fork lifts, scaffolding, etc.

As described above, the present invention is used for conducting a meeting in a
25 virtual environment using intelligent 3-D models of a manufacturing facility. This is particularly advantageous for use to improve manufacturing facility and asset operation, maintenance, and training. For example, instead of requiring a number of persons to travel to a single manufacturing facility to evaluate the operation and/or maintenance issues with the facility, these issues can be
30 addressed with one or more of the people being located at remote locations. Further, instead of requiring people to travel to a particular facility to train on the operation of one or more components (e.g., machines) of the facility, these people can be remotely trained using the present invention. The use of real-

time data in the intelligent 3-D model leads to a reduction in travel costs, allows full participation by all persons, and does not require taking expensive manufacturing equipment off line for training and maintenance purposes, which is expensive and disruptive to the manufacturing process.

5   Furthermore, the virtual environment produces significant safety advantages by reducing the time personnel spend within a live plant environment.

The use of intelligent 3-D models provides significant advantages over conventional 2-D drawings. Whereas 2-D drawings (e.g., isometric drawings)
10   are prone is misunderstanding, the 3-D models of the present invention allow for easy comprehension of the modeled element. Furthermore, 2-D drawings typically reflect only the design of the system, whereas the intelligent 3-D models of the present invention not only represent what was actually built, but also any later improvements or other developments. Additionally, typical 3-D
15   models are static and are not updated as modifications are made to process equipment, whereas the intelligent 3-D models of the present invention account for modifications.

Other embodiments of the present invention and its individual components will
20   become readily apparent to those skilled in the art from the foregoing detailed description. As will be realized, the invention is capable of other and different embodiments, and its several details are capable of modifications in various obvious respects, all without departing from the spirit and the scope of the present invention. Accordingly, the drawings and detailed description are to be
25   regarded as illustrative in nature and not as restrictive. It is therefore not intended that the invention be limited except as indicated by the appended claims.

WHAT IS CLAIMED IS:

1.   A method of conducting a meeting between a plurality of people, the method comprising:

outputting, on a display associated with each of the plurality of people, a virtual conference room that includes

an avatar associated with each of the plurality of people, and

a virtual display that displays a 3-D model of a manufacturing facility;

receiving a selection of an object of the 3-D model; and

displaying on the virtual display information associated with the selected object of the 3-D model; and

outputting, on the display associated with each of the plurality of people, the virtual conference room and the virtual display with the information associated with the selected object of the 3-D model.

2.   The method of claim 1, wherein the manufacturing facility is an oil refinery.

3.   The method of claim 2, wherein the selected object is one of a vessel, rotating machinery, separation equipment and vessels, mixing equipment and vessels, reaction equipment and vessels, associated valves, piping instrumentation elements and other structures.

5   4.   The method of claim 1, wherein the information associated with the selected object is maintenance data, operational data, inspection data or a document associated with the selected object.

5.   The method of claim 1, wherein the information associated with the selected object is a plurality of sub-objects.

6.   The method of claim 5, comprising:

        receiving a selection of one of the sub-objects;

        displaying on the virtual display information associated with the selected sub-object of the 3-D model; and

        outputting, on the display associated with each of the plurality of people, the virtual conference room and the virtual display with the information associated with the selected sub-object of the 3-D model.

7.   The method of claim 6, wherein the information associated with the selected sub-object is maintenance data, operational data, inspection data or a document associated with the selected object.

8.   A system for conducting a meeting between a plurality of people, the system comprising:

        a server that executes a computer program to produce a virtual environment that includes a virtual conference room;

        a plurality of user terminals, associated with each of the plurality of people, coupled to the server by a network; and

        manufacturing facility information storage coupled to the server,

        wherein the server includes display logic to provide an output of the virtual conference room to a display associated with each of the plurality of user terminals, the virtual conference room including

                an avatar associated with each of the plurality of people, and

                a virtual display that displays a 3-D model of a manufacturing facility;

        wherein the server includes selection logic that receives a selection of an object of the 3-D model, and in response to the selection the display logic provides an output to the display associated with each of the plurality of people with the virtual display with the information associated with the selected object of the 3-D model.

9.   The system of claim 13, wherein the manufacturing facility is an oil refinery.

10.   The system of claim 14, wherein the selected object is one of a vessel, rotating machinery, separation equipment and vessels, mixing equipment and vessels, reaction equipment and vessels, associated valves, piping instrumentation elements and other structures.

5   11.   The system of claim 13, wherein the information associated with the selected object is maintenance data, operational data, inspection data or a document associated with the selected object.
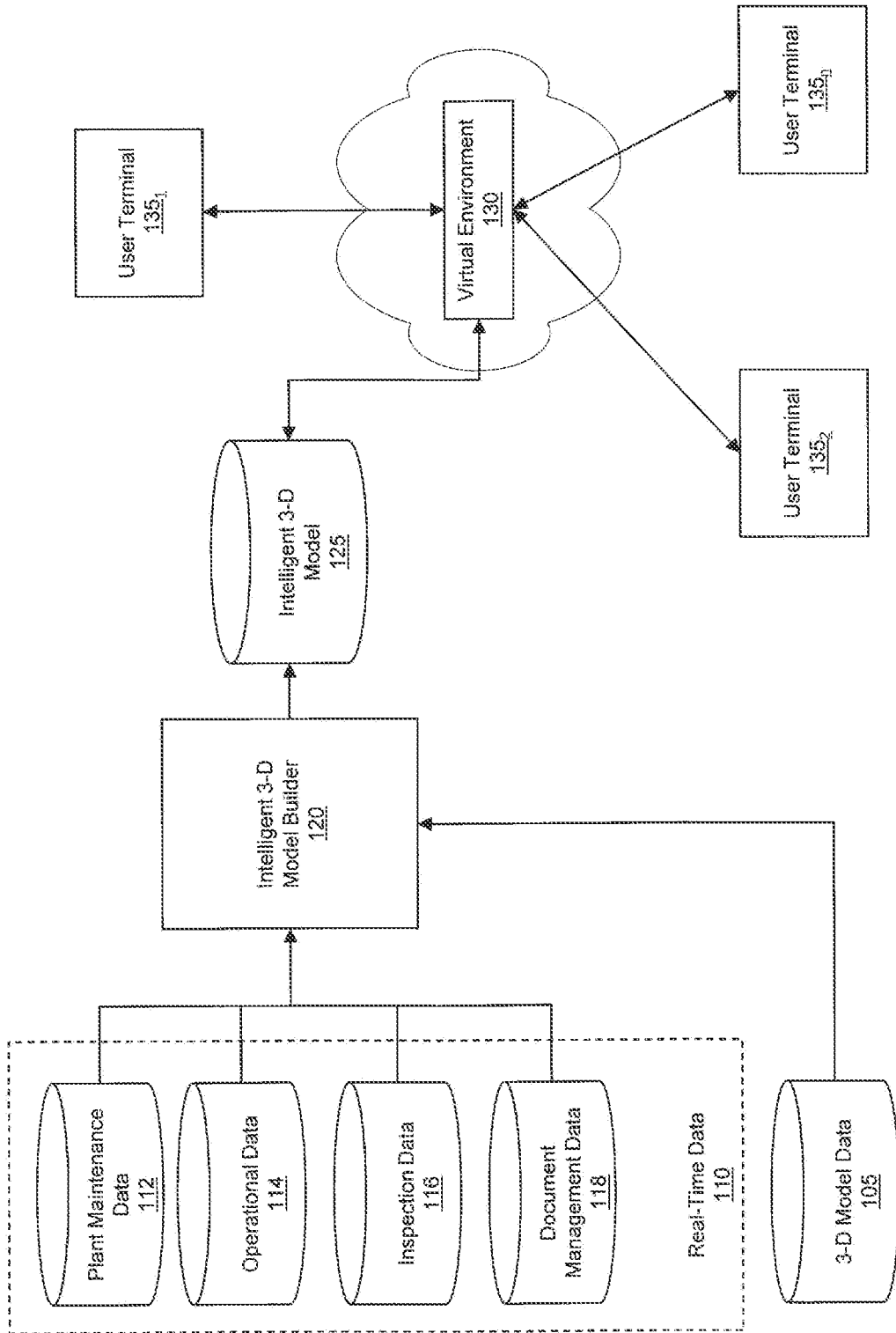
12.   The system of claim 13, wherein the information associated with the selected object is a plurality of sub-objects.

13.   The system of claim 17, wherein when the selection logic receives a selection of one of the sub-objects, the display logic provides an output to the display associated with each of the plurality of people of the virtual conference room and the virtual display with the information associated with the selected sub-object of the 3-D model.

10   14.   The system of claim 18, wherein the information associated with the selected sub-object is maintenance data, operational data, inspection data or a document associated with the selected object.
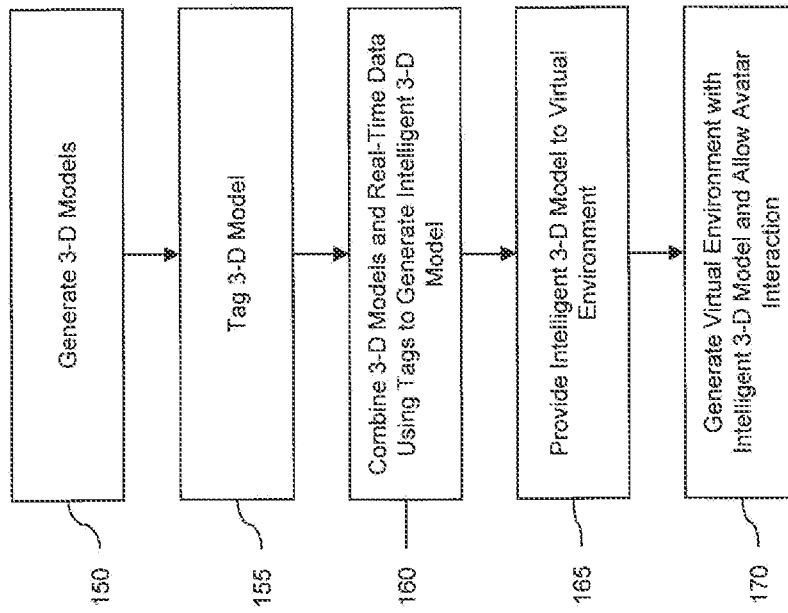
FIGURE 1A

FIGURE 1B

Generate 3-D Models — 150

Tag 3-D Model — 155

Combine 3-D Models and Real-Time Data Using Tags to Generate Intelligent 3-D Model — 160

Provide Intelligent 3-D Model to Virtual Environment — 165
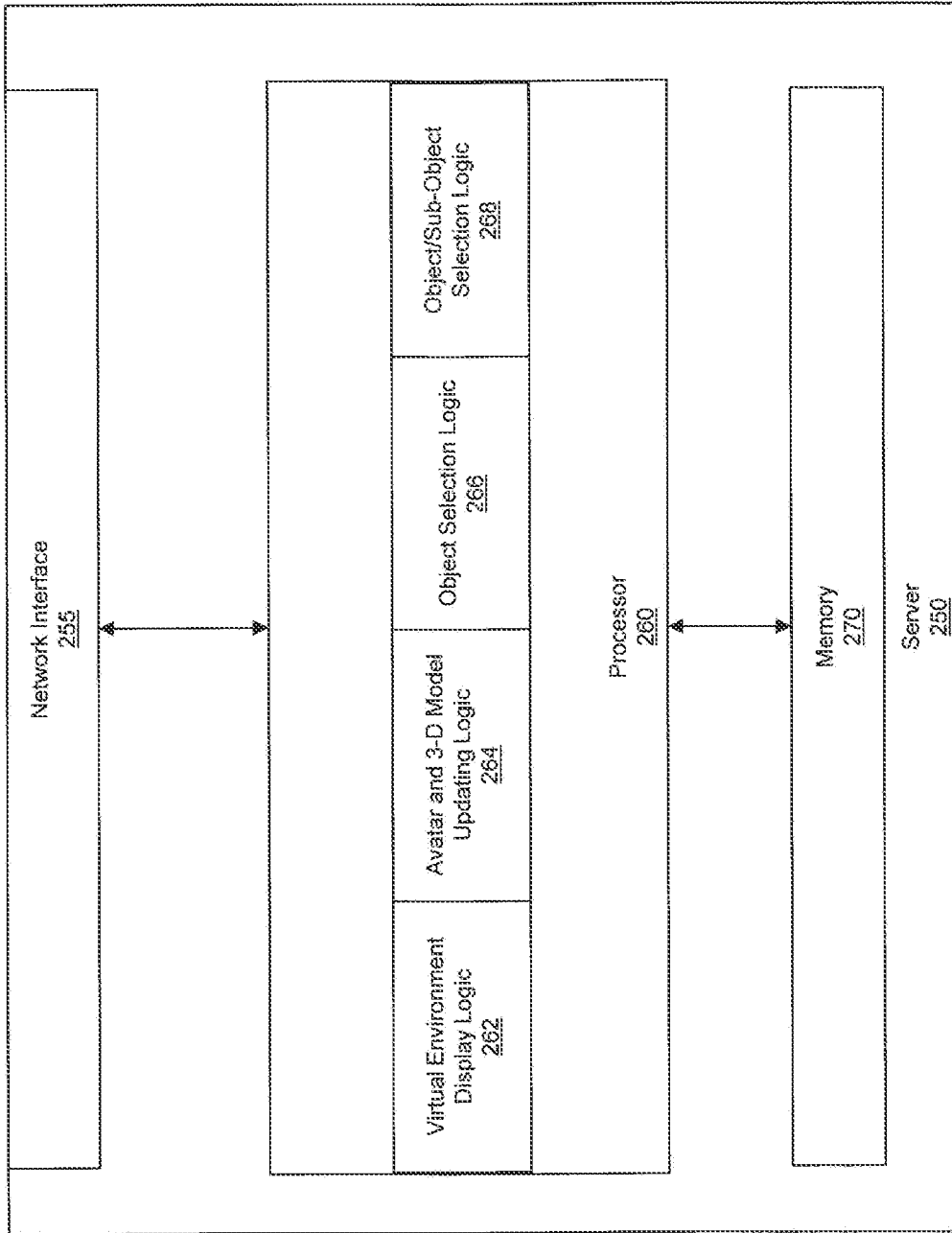
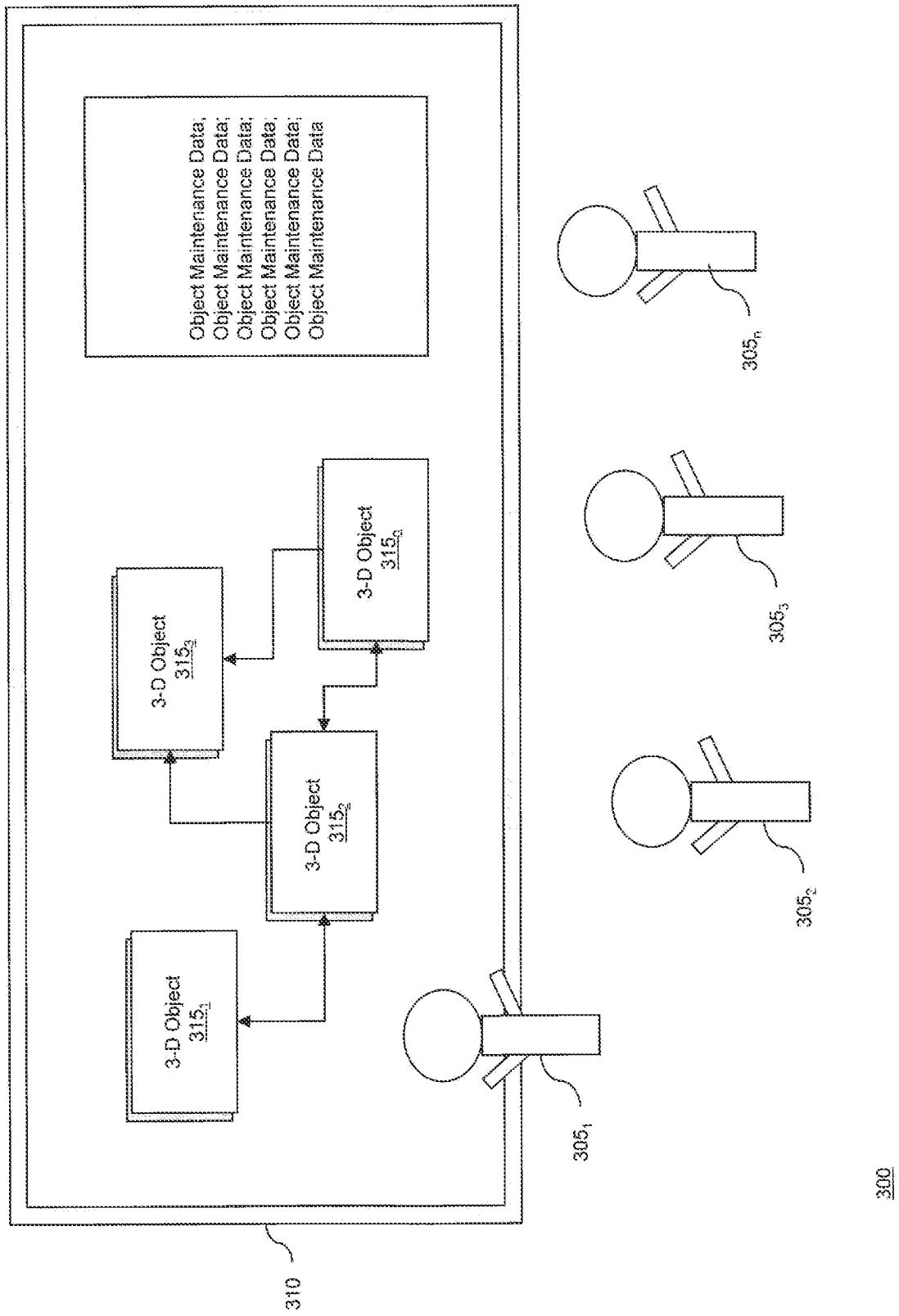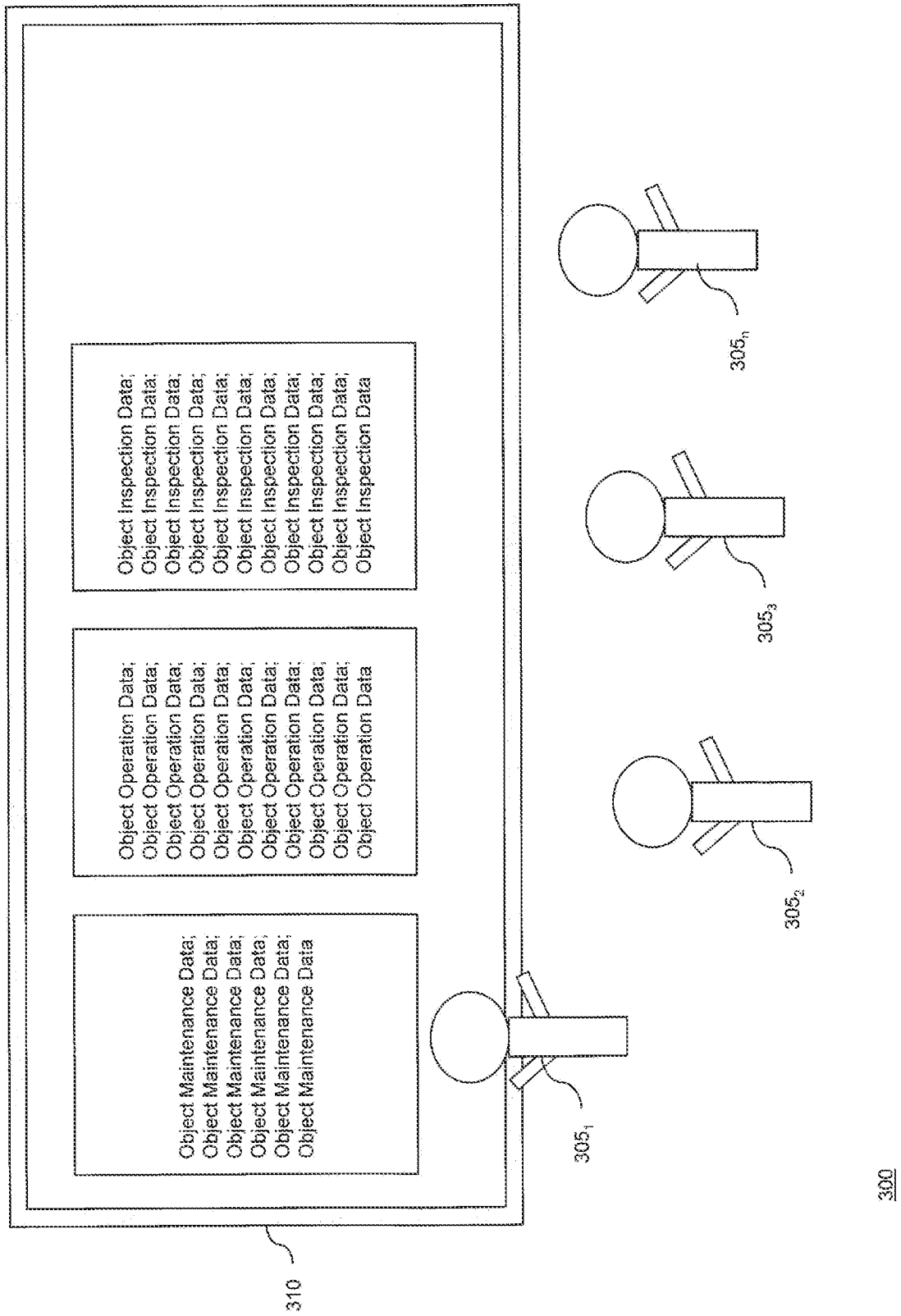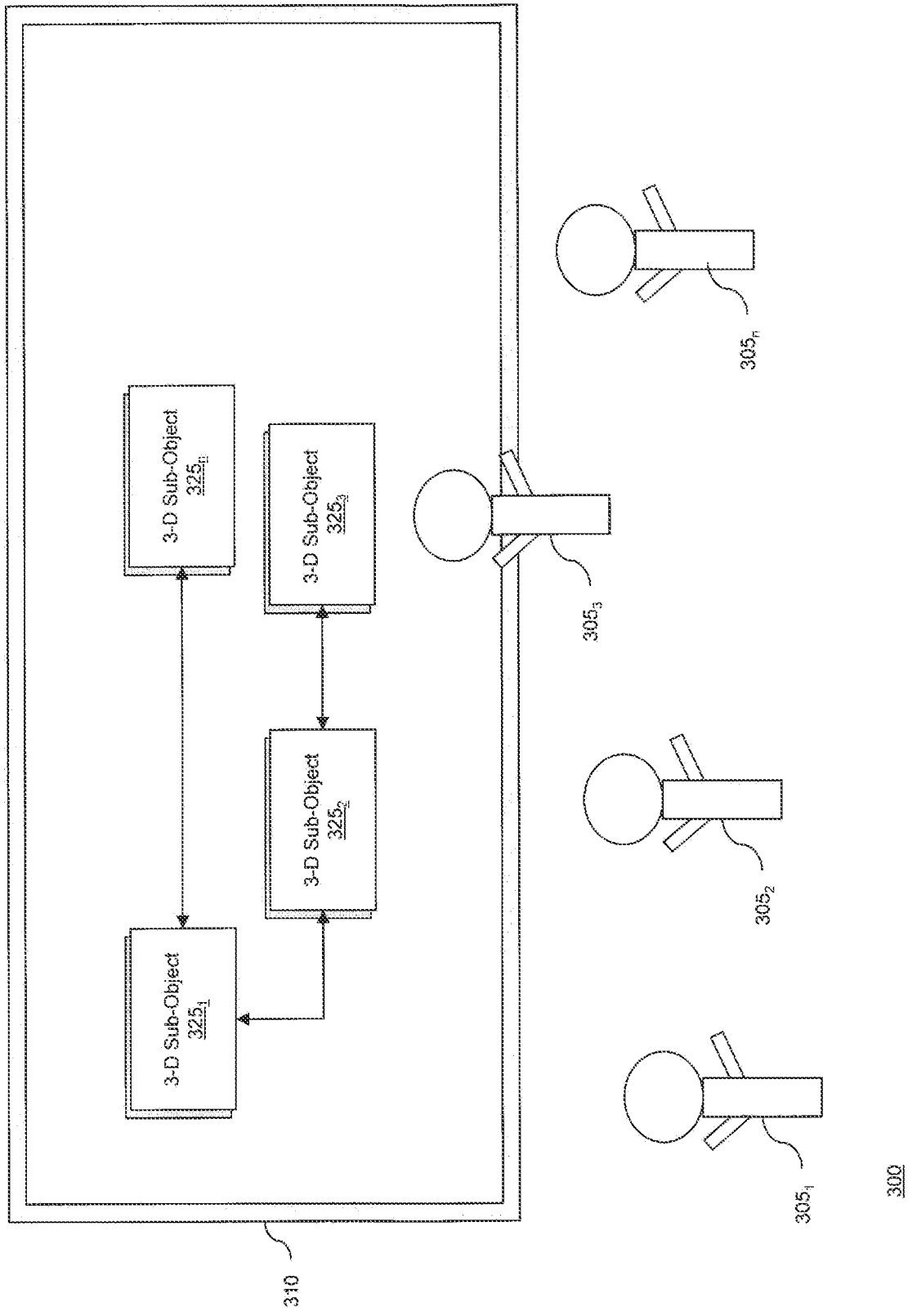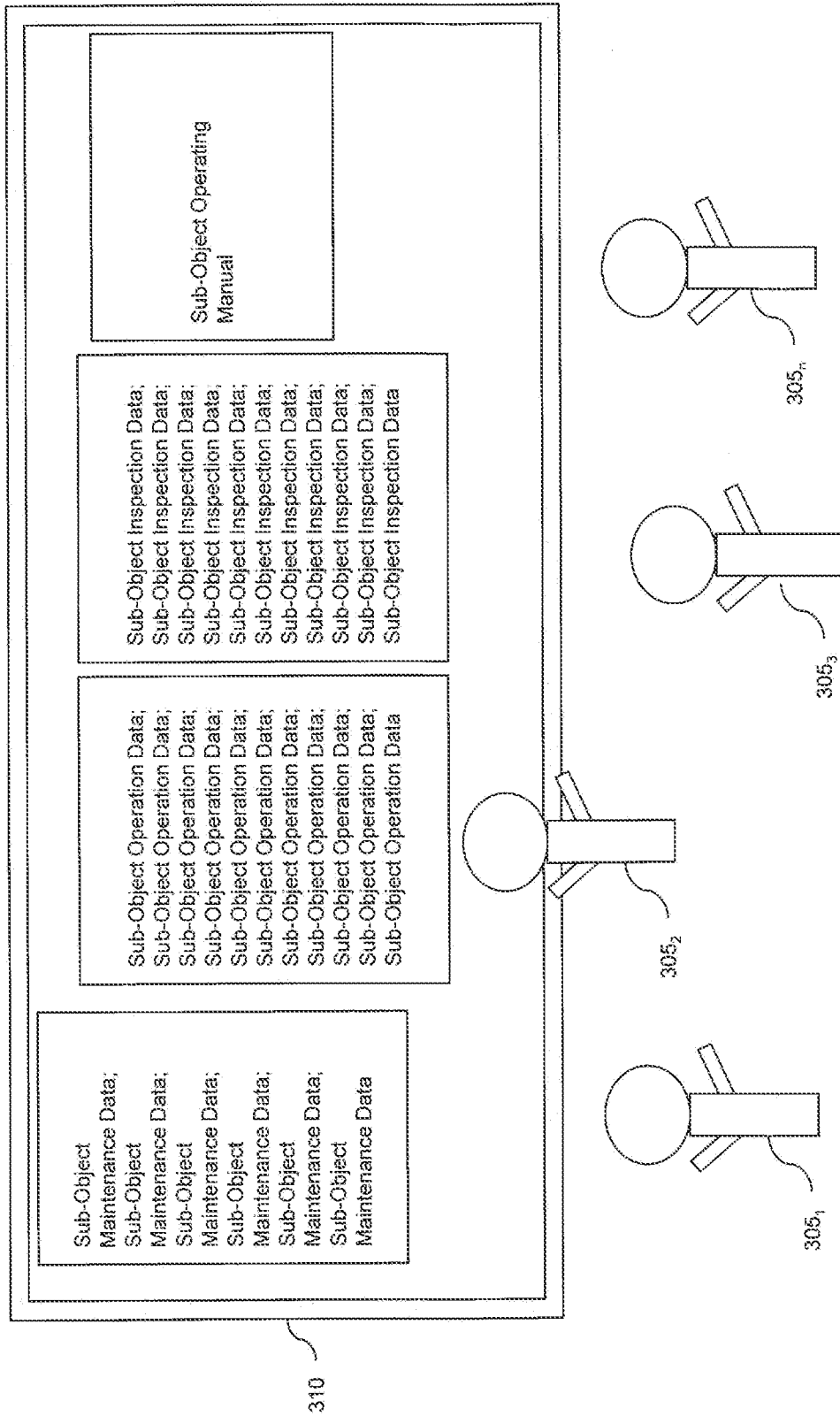Generate Virtual Environment with Intelligent 3-D Model and Allow Avatar Interaction — 170
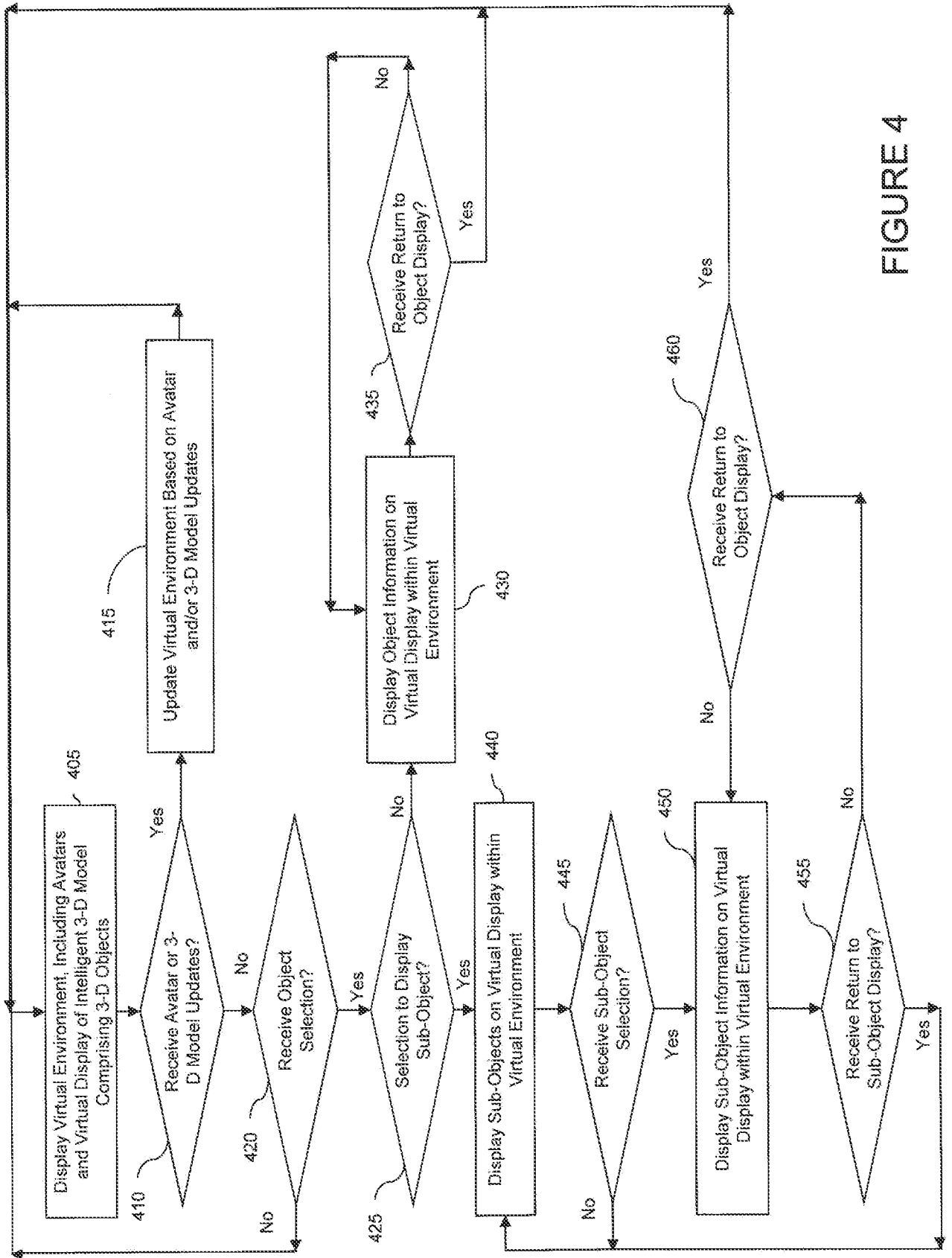
FIGURE 2

FIGURE 3A

FIGURE 3B

FIGURE 3C

FIGURE 3D

FIGURE 4