provides a perspective view of certain ones of the objects. Spot 9 is similar to an overhead virtual camera, that sits slightly behind or above the HMD player 100, which provides a substantially similar view into the virtual reality environment 450, and the virtual player view 602. Therefore, as the HMD player 100 moves around, different ones of the viewing spots can be selected dynamically for the spectator 150. As mentioned above, the spectator 150 can be co-located with the HMD player 100, or can be a remote spectator that's viewing the HMD player 100 virtual environment from a website, an HMD connected to the Internet, a remote device, a television, or portable device.

[0095] Furthermore, different users, which are spectators, can be provided with different spots into the VR player view 602. The different users can be provided with different views, based on preferences of the specific users, which may be saved to user profiles. For instance, some users may have a preference identified in their profile that dictate that they like to see certain types of objects or like to see certain types of view perspectives. As a result, the spots can be customized for the users, and can also be customized for the users based on pre-authored locations. In some embodiments, the locations need not be pre-authored, but can be dynamically selected based on the content presented in the virtual reality environment 450. Broadly speaking, the viewing angles within the virtual reality environment 454 spectators can be set dynamically, based on a number of criteria.

[0096] The criteria can be based on pre-authored viewing spots, can be based on preferences of the spectators, can be based on dynamically placed viewing spots based on changing content within the virtual reality environment 450, or can be moved and adjusted by the spectator. If the spectator is provided with options for moving the view location into the virtual environment 450, those views provided to

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spectators can be different depending on the spectator that is watching the content being navigated or watched by the HMD player 100.

[0097] Figure 7 illustrates a table defining various spectators 702 that may be viewing different types of content 704 of HMD players, in accordance with one embodiment. As shown, for user 1, who is the spectator in figure 6, the multimedia virtual-reality content is game 1. Game 1 is the content that the HMD player is navigating, and based on the navigation within the content by the HMD player, the spectator that is user 1, will be provided with pre-authored viewing spots 706. As shown in figure 6, the spots provided for user 1 are spots 3 →6→9→N. In each of the viewing spots, interesting objects (O) 708 are viewable from those specific viewing spots. The viewing spots therefore provide viewing angles to view objects O1-O14, depending on the viewing perspective. A different spectator, such as user 2, may also be viewing the game 1 activity. However, that user may have a different preference for types of content that is interesting to that user. For this reason, the system can select different pre-authored viewing spots 1→4→9→N, than those provided to user 1. Similarly, the interesting objects that are provided for those spots will change, as viewed by the spectator user 2. This example is provided to emphasize that any number of users may be spectators, and those users can spectate into the same virtual-reality content navigated by the HMD user, and can individually be provided with different and unique viewing spots or angles into the virtual-reality content.

[0098] Continuing with this example, user 3 and user 4 may be viewing different environments, other than game 1. As noted above, the content does not have to be games, but can be any type of multimedia content, or content that can be displayed on a screen. The content can include, without limitation, graphical objects, text, associated audio, multimedia, interactive content, movie content, audio content,

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controllable character content, avatars, maneuverable objects, selectable objects, communication objects, interfacing objects, remote touring locations, demonstration videos, tourism content, amusement park content, or combinations thereof. Thus, depending on the environment, different pre-authored viewing spots X→N, and Y→N, can be provided that provide unique viewing of certain interesting objects or content within the virtual-reality environment 450.

[0099] Figure 8A illustrates an example of an HMD player 100, interacting with a video game scene depicted in the virtual reality environment 450, in accordance with one embodiment. The videogame provides, by way of example, a path along a corridor of walls that requires the user (first-person) controlled by the HMD player 100 to traverse. In this example, the HMD player 100 may be searching for bad guys 820, which may be hiding in some location along the corridor of the game. The HMD player, referred to herein as the HMD VR player (HVP), is shown moving between location 802, 803, and 804. A spectator 150 is provided with a view into the corridor depicted in the virtual-reality environment 450. The views provided to the spectator 150 may be customized based on the location of the first-person player controlled by the HMD player 100.

[00100] Different views into the corridor are provided to the HMD player 100 in locations 802 and locations 803. Once the HMD player reaches location 804, that view into the corridor may be limited due to the walls, thus providing a view that encompasses area A. The spectator 150, in one embodiment, is provided with various views into the virtual environment 450, based on one or more pre-authored spots. In this example, the spectator 150 is provided with spectator view S-view 1 at location 810 and spectator view S-view 2 at location 812. At location 810, the spectator view shows the character controlled by the HMD player 100 walking down the corridor

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toward the corner, and then the spectator view can shift to location 812, which will provide a more interesting view of the character controlled by the HMD player 100. At this point, at location 812, the spectator view may be limited to a subset of the view that is provided to the HMD player 100, namely area A.

[00101] However, location 812 also provides possible viewing of the bad guys 820 that are currently outside of the point of view of the HMD player 100. In one embodiment, the spectator view S view-2 is provided with additional area B for viewing, which is not yet viewable by the HMD player 100. This may provide the option for the spectator to see that the bad guys 820 are hiding around the corner, and may provide for an interesting action scene when the HMD player (first-person character) reaches that location. This may provide an extra level of excitement to the spectator, whereas the spectator knows that an interesting event will occur even before the HMD player knows that the event may occur.

[00102] In one embodiment, the extra content provided to the spectator is not made knowable to the HMD player 100, to avoid providing unfair notice to the HMD player. This prohibition of transferring the knowledge or information may be required depending on the game, which requires a level of skill by the HMD player. In other embodiments, it is possible for the HMD player to be provided with knowledge of certain content by spectators. Depending on the game criticality of data sharing or ambition of data sharing, spectators may be either prohibited from sharing information with the HMD player or can provide information to the HMD player. By way of example, if the spectator 150 is viewing from a remote website, e.g., a twitch site, that spectator can provide or feedback information to the HMD player in a number of ways. The information can be by way of text communication, chat

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communication, voice communication, audio communication, or combinations thereof.

[00103] Figure 8B illustrates a table that shows different HMD player views 830, and the views that may be provided to spectators, in accordance with one embodiment. In some embodiments, the spectator views can be preset based on pre-authored spots, as described above. In other embodiments, the spectator views can shift simply to keep up with the location of the HMD player. When keeping up with the HMD player, the view may be selected proximate to the HMD player, looking at the HMD player, or in the form of a virtual floating virtual camera located above the head location of the HMD player. As shown in figure AB, the spectator view position 832 can change based on the HMD virtual reality player view (HVP) that is created based on the activity and control of the HMD player 100.

[00104] For instance, when the HVP is at view -3, the spectator view is automatically moved to spectator view S-view 2. This table also shows, for purposes of completeness, what the HMD VR player sees, from the various HVP views. When the HMD player is provided with HVP view-2, the area that is viewable is identified by A, as described with reference to figure 8A. In one embodiment, the spectator will see views 836, which follow the same views provided to the HMD player 100. That is, no additional content is provided to the spectator, other than the scene content that is viewable by the HMD player.

[00105] However, even if the same content is provided to the spectator, the spectator can have a different viewpoint into that same content. In another embodiment, the spectator can see more than the HMD player, in option 838. In this option, in view HVP view-3, the HMD player will see area A, whereas the spectator can be provided with additional viewing area B, in addition to area A. This additional

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area for viewing is provided to the spectator, since the spectator is located from a point of view that would provide a logically unobstructed view of certain content from that point of view, which is not the same as the point of view provided to the HMD player 100. As mentioned above, when additional content is viewable by the spectator, the spectator can either be allowed to share that information with the HMD player or prevented from sharing that information with the HMD player.

[00106] Figure 9 illustrates an embodiment where in HMD player 100 is viewing into a virtual reality environment 450, and the gaze direction 901 of the HMD player is identified. As mentioned above, one embodiment provides the ability to identify where the HMD player 100 is looking within the virtual reality environment 450. This information can be useful to a spectator 150, whom may desire to know what interesting content the HMD player 100 is looking at. In the context of a movie, the HMD player may be looking at an interesting scene. In the context of a demonstration, the HMD player may be looking at a specific feature of the demonstration object or lecture.

[00107] In the context of a game, the HMD player may be looking at specific character, object, area, etc. In one embodiment, the gaze direction 901 is detected by the HMD camera 312, which allows for detection that the HMD player 100 is looking at object 902. In this example, object 902 is represented as a girl standing next to a building. Although there are various other objects in the virtual reality environment 450, the HMD player 100 is focused on object 902. The spectator 150 would like to know where in the virtual reality environment 450 the HMD player 100 is looking. To do this, once it is determined where the HMD player 100 is focused viewing, that area of the virtual reality scene can be highlighted or identified so that the spectator 150 can visually know where the HMD player is looking.

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[00108] As mentioned above, identifying that object 902 is the focus of the gaze direction 901 of the HMD player 100 can be conveyed by modifying the representation or area around or proximate or at the object 902. Object 902 may be highlighted, may be changed in color, may be grayed out, may be identified by a pointer, may be identified with text, may be allowed to flash in different colors, may provide one or more flash changes in image, may provide a sound, may provide a special movement, or combinations thereof. These identified ways of highlighting object 902, in one embodiment, are illustrated when viewed from the viewpoint of the spectator 150. In this example, the spectator 150 is viewing from a spot 906, which is similar to a floating virtual camera over the head of the HMD player 100. However, the spot for viewing into the virtual reality environment 450 may be located in other places, as noted above.

[00109] However, the identification that the HMD player 100 is viewing object 902, is represented to the view provided to the spectator 150. Thus, in one embodiment, the highlighting of the object 902 will not be visible to the HMD player 100, but simply visible to the spectator 150. In other embodiments, the spectator can determine by way of a selection object whether to activate or deactivate the ability to identify where the HMD player 100 is looking. Furthermore, multiple spectators can be viewing the same content being navigated by the HMD player 100, and different ones of those spectators can activate or deactivate this feature to allow knowledge of what the HMD player is looking at within the virtual environment.

[00110] In some embodiments, activating this feature can be automatic, and can be triggered based on the type of content being viewed by the HMD player. This way, the spectator can simply watch the content being navigated by the HMD player 100, and when certain objects should be highlighted to the spectator, the game

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developer can predefine certain times for identifying the gaze direction of the HMD player to highlight certain objects to the spectators. In further embodiments, some spectators may require more highlighting, e.g., such as for novice spectators. More experienced spectators may require less highlighting or assistance during the viewing of the HMD player activity. Accordingly, activating and the activating the gaze direction identification of gaze direction/viewable object identification can be toggled depending on developer settings, the spectators, the HMD player, complexity of the content, or combinations thereof.

[00111] Figure 10 illustrates an example where an HMD player 100 may be interacting with a virtual reality environment 450, and different types of activity are occurring therein. In this example, the virtual reality environment 450 includes a truck 922, a building 920, a car crash 924, and various other types of content. In one configuration, different activity will also produce different sounds that are being generated and listened to by the HMD player 100 by way of headphones 940. If the perspective of the HMD player 100 is from a first-person point of view, the sounds being generated within the virtual reality environment 450 will be relative to the position of the HMD player 100.

[00112] In this example, the car crash 924 may sound further away and possibly the HMD player 100 may not be able to listen to conversations had in the various listening zones 1, 2, and 3. If the HMD player 100 were to approach those listening zones, the sounds for those listening zones would then change, along with any associated acoustics to provide a realistic listening environment, as if the player were actually in the virtual reality scene. From the point of view of the spectator 150, the spectator 150 may be provided different points of view into the virtual reality

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environment 450, as described above. In some configurations, the spectator 150 may desire to listen in at different listening zones.

[00113] The spectator may be provided with functionality to select different listening zones, which would impact the audio provided to the spectator 150, and listened to via headphones 942. By way of example, if the spectator 150 desires to listen in to listening zone 1, the spectator 150 may be able to hear a conversation had by virtual reality players or artificial intelligence (AI) characters in listening zone 1. The spectator 150 can therefore be placed in that listening zone, and sounds coming from other listening zones will be generated to the spectator 150 as if the spectator 150 were in the listening zone 1. The same is true if the spectator 150 decides to select the listen to listening zone 2, which may be a conversation being had by a person standing inside of a three story office building 920.

[00114] And also, the spectator 150 can similarly listen to listening zone 3, to hear what's going on with respect to the car crash 924. In this example, the spectator 150 is also using an HMD 102. The spectator 150 may be using glove gestures 930 for selecting the listening zones. In other embodiments, the spectator can be using a controller, a keyboard, hand gestures without gloves, voice input, gaze input, etc., to direct which listening zone is interesting to the spectator 150. Still further, the spectator can simply be viewing the content from a display screen connected to a website, such as a twitch-type site. In some embodiments, a personal computer (PC), game console, smart phone, tablet computer, etc., may be used to view the virtual reality environment 450, which is being played by the HMD player 100.

[00115] In some embodiments, the content viewed by the HMD player via the HMD 102 can be modified so that it can be displayed on a two-dimensional

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screen. For example, a 3-D to 2-D conversion can be performed on the content before it's shared to the twitch-type service. In other embodiments, the full 3-D content can be shared to the twitch-type service, and the spectator connected to the twitch-type service can be viewing the content via an HMD. It should be understood that the way in which spectators can consume the virtual reality environment 450 can vary, and the functionality provided to spectators can also vary. Broadly speaking, spectators can be provided with highlighting to see where HMD player's 100 are looking, such as in figure 9, and can also be provided with dynamic selectable settings to allow listening a specific locations within a virtual reality scene.

[00116] Furthermore, the spectators can be provided with different viewing spots into the virtual reality environment 450. These viewing spots can be dynamically controlled or pre-authored, to provide specific viewing locations and angles to the spectators. These functionalities provide for dynamic and enhanced spectating abilities, that will enhance the experience a spectators viewing HMD navigated content. As mentioned above, these embodiments also facilitate spectators to view the content in a more normal way that is not tied to the rapid movements of an HMD player's head, which can cause disorientation or simply discomfort in watching the HMD content.

[00117] Providing spectator viewing spots, which may move gradually or slowly depending on the location of the HMD player, provides for an easy way of looking into the virtual reality content being enjoyed by the HMD player. Spectators can therefore watch the content with ease, and are provided with ways of improving the watching enjoyment, or participation in the game play or multimedia content viewing via the HMD devices. By providing these enriched functionalities, spectators are no longer tied to the fixed viewing angles of the HMD player, and are no longer

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forced to view the same exact views nor to exactly follow the motions being driven by an HMD player.

[00118] With reference to Figure 11, a diagram illustrating components of a head-mounted display 102 is shown, in accordance with an embodiment of the disclosure. The head-mounted display 102 includes a processor 1300 for executing program instructions. A memory 1302 is provided for storage purposes, and may include both volatile and non-volatile memory. A display 1304 is included which provides a visual interface that a user may view. A battery 1306 is provided as a power source for the head-mounted display 102. A motion detection module 1308 may include any of various kinds of motion sensitive hardware, such as a magnetometer 1310, an accelerometer 1312, and a gyroscope 1314.

[00119] An accelerometer is a device for measuring acceleration and gravity induced reaction forces. Single and multiple axis models are available to detect magnitude and direction of the acceleration in different directions. The accelerometer is used to sense inclination, vibration, and shock. In one embodiment, three accelerometers 1312 are used to provide the direction of gravity, which gives an absolute reference for two angles (world-space pitch and world-space roll).

[00120] A magnetometer measures the strength and direction of the magnetic field in the vicinity of the head-mounted display. In one embodiment, three magnetometers 1310 are used within the head-mounted display, ensuring an absolute reference for the world-space yaw angle. In one embodiment, the magnetometer is designed to span the earth magnetic field, which is ±80 microtesla. Magnetometers are affected by metal, and provide a yaw measurement that is monotonic with actual yaw. The magnetic field may be warped due to metal in the environment, which causes a warp in the yaw measurement. If necessary, this warp can be calibrated

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using information from other sensors such as the gyroscope or the camera. In one embodiment, accelerometer 1312 is used together with magnetometer 1310 to obtain the inclination and azimuth of the head-mounted display 102.

[00121] In some implementations, the magnetometers of the head-mounted display are configured so as to be read during times when electromagnets in other nearby devices are inactive.

[00122] A gyroscope is a device for measuring or maintaining orientation, based on the principles of angular momentum. In one embodiment, three gyroscopes 1314 provide information about movement across the respective axis (*x, y* and *z)* based on inertial sensing. The gyroscopes help in detecting fast rotations. However, the gyroscopes can drift overtime without the existence of an absolute reference. This requires resetting the gyroscopes periodically, which can be done using other available information, such as positional/orientation determination based on visual tracking of an object, accelerometer, magnetometer, etc.

[00123] A camera 1316 is provided for capturing images and image streams of a real environment. More than one camera may be included in the head-mounted display 102, including a camera that is rear-facing (directed away from a user when the user is viewing the display of the head-mounted display 102), and a camera that is front-facing (directed towards the user when the user is viewing the display of the head-mounted display 102). Additionally, a depth camera 1318 may be included in the head-mounted display 102 for sensing depth information of objects in a real environment.

[00124] The head-mounted display 102 includes speakers 1320 for providing audio output. Also, a microphone 1322 may be included for capturing

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audio from the real environment, including sounds from the ambient environment, speech made by the user, etc. The head-mounted display 102 includes tactile feedback module 1324 for providing tactile feedback to the user. In one embodiment, the tactile feedback module 1324 is capable of causing movement and/or vibration of the head-mounted display 102 so as to provide tactile feedback to the user.

[00125] LEDs 1326 are provided as visual indicators of statuses of the head-mounted display 102. For example, an LED may indicate battery level, power on, etc. A card reader 1328 is provided to enable the head-mounted display 102 to read and write information to and from a memory card. A USB interface 1330 is included as one example of an interface for enabling connection of peripheral devices, or connection to other devices, such as other portable devices, computers, etc. In various embodiments of the head-mounted display 102, any of various kinds of interfaces may be included to enable greater connectivity of the head-mounted display 102.

[00126] A WiFi module 1332 is included for enabling connection to the Internet or a local area network via wireless networking technologies. Also, the head-mounted display 102 includes a Bluetooth module 1334 for enabling wireless connection to other devices. A communications link 1336 may also be included for connection to other devices. In one embodiment, the communications link 1336 utilizes infrared transmission for wireless communication. In other embodiments, the communications link 1336 may utilize any of various wireless or wired transmission protocols for communication with other devices.

[00127] Input buttons/sensors 1338 are included to provide an input interface for the user. Any of various kinds of input interfaces may be included, such as buttons, touchpad, joystick, trackball, etc. An ultra-sonic communication module

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1340 may be included in head-mounted display 102 for facilitating communication with other devices via ultra-sonic technologies.

[00128] Bio-sensors 1342 are included to enable detection of physiological data from a user. In one embodiment, the bio-sensors 1342 include one or more dry electrodes for detecting bio-electric signals of the user through the user's skin.

[00129] A video input 1344 is configured to receive a video signal from a primary processing computer (e.g. main game console) for rendering on the HMD. In some implementations, the video input is an HDMI input.

[00130] The foregoing components of head-mounted display 102 have been described as merely exemplary components that may be included in head-mounted display 102. In various embodiments of the disclosure, the head-mounted display 102 may or may not include some of the various aforementioned components. Embodiments of the head-mounted display 102 may additionally include other components not presently described, but known in the art, for purposes of facilitating aspects of the present disclosure as herein described.

[00131] Figure 12 is a block diagram of a Game System 1400, according to various embodiments of the disclosure. Game System 1400 is configured to provide a video stream to one or more Clients 1410 via a Network 1415. Game System 1400 typically includes a Video Server System 1420 and an optional game server 1425. Video Server System 1420 is configured to provide the video stream to the one or more Clients 1410 with a minimal quality of service. For example, Video Server System 1420 may receive a game command that changes the state of or a point of view within a video game, and provide Clients 1410 with an updated video stream reflecting this change in state with minimal lag time. The Video Server System 1420

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may be configured to provide the video stream in a wide variety of alternative video formats, including formats yet to be defined. Further, the video stream may include video frames configured for presentation to a user at a wide variety of frame rates. Typical frame rates are 30 frames per second, 60 frames per second, and 120 frames per second. Although higher or lower frame rates are included in alternative embodiments of the disclosure.

[00132] Clients 1410, referred to herein individually as 1410A., 1410B., etc., may include head mounted displays, terminals, personal computers, game consoles, tablet computers, telephones, set top boxes, kiosks, wireless devices, digital pads, stand-alone devices, handheld game playing devices, and/or the like. Typically, Clients 1410 are configured to receive encoded video streams, decode the video streams, and present the resulting video to a user, e.g., a player of a game. The processes of receiving encoded video streams and/or decoding the video streams typically includes storing individual video frames in a receive buffer of the Client. The video streams may be presented to the user on a display integral to Client 1410 or on a separate device such as a monitor or television. Clients 1410 are optionally configured to support more than one game player. For example, a game console may be configured to support two, three, four or more simultaneous players. Each of these players may receive a separate video stream, or a single video stream may include regions of a frame generated specifically for each player, e.g., generated based on each player's point of view. Clients 1410 are optionally geographically dispersed. The number of clients included in Game System 1400 may vary widely from one or two to thousands, tens of thousands, or more. As used herein, the term "game player" is used to refer to a person that plays a game and the term "game playing device" is used to refer to a device used to play a game. In some embodiments, the game playing

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device may refer to a plurality of computing devices that cooperate to deliver a game experience to the user. For example, a game console and an HMD may cooperate with the video server system 1420 to deliver a game viewed through the HMD. In one embodiment, the game console receives the video stream from the video server system 1420, and the game console forwards the video stream, or updates to the video stream, to the HMD for rendering.

[00133] Clients 1410 are configured to receive video streams via Network 1415. Network 1415 may be any type of communication network including, a telephone network, the Internet, wireless networks, powerline networks, local area networks, wide area networks, private networks, and/or the like. In typical embodiments, the video streams are communicated via standard protocols, such as TCP/IP or UDP/IP. Alternatively, the video streams are communicated via proprietary standards.

[00134] A typical example of Clients 1410 is a personal computer comprising a processor, non-volatile memory, a display, decoding logic, network communication capabilities, and input devices. The decoding logic may include hardware, firmware, and/or software stored on a computer readable medium. Systems for decoding (and encoding) video streams are well known in the art and vary depending on the particular encoding scheme used.

[00135] Clients 1410 may, but are not required to, further include systems configured for modifying received video. For example, a Client may be configured to perform further rendering, to overlay one video image on another video image, to crop a video image, and/or the like. For example, Clients 1410 may be configured to receive various types of video frames, such as I-frames, P-frames and B-frames, and to process these frames into images for display to a user. In some embodiments, a

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member of Clients 1410 is configured to perform further rendering, shading, conversion to 3-D, or like operations on the video stream. A member of Clients 1410 is optionally configured to receive more than one audio or video stream. Input devices of Clients 1410 may include, for example, a one-hand game controller, a two-hand game controller, a gesture recognition system, a gaze recognition system, a voice recognition system, a keyboard, a joystick, a pointing device, a force feedback device, a motion and/or location sensing device, a mouse, a touch screen, a neural interface, a camera, input devices yet to be developed, and/or the like.

[00136] The video stream (and optionally audio stream) received by Clients 1410 is generated and provided by Video Server System 1420. As is described further elsewhere herein, this video stream includes video frames (and the audio stream includes audio frames). The video frames are configured (e.g., they include pixel information in an appropriate data structure) to contribute meaningfully to the images displayed to the user. As used herein, the term "video frames" is used to refer to frames including predominantly information that is configured to contribute to, e.g. to effect, the images shown to the user. Most of the teachings herein with regard to "video frames" can also be applied to "audio frames."

[00137] Clients 1410 are typically configured to receive inputs from a user. These inputs may include game commands configured to change the state of the video game or otherwise affect game play. The game commands can be received using input devices and/or may be automatically generated by computing instructions executing on Clients 1410. The received game commands are communicated from Clients 1410 via Network 1415 to Video Server System 1420 and/or Game Server 1425. For example, in some embodiments, the game commands are communicated to Game Server 1425 via Video Server System 1420. In some embodiments, separate copies of

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the game commands are communicated from Clients 1410 to Game Server 1425 and Video Server System 1420. The communication of game commands is optionally dependent on the identity of the command. Game commands are optionally communicated from Client 1410A through a different route or communication channel that that used to provide audio or video streams to Client 1410A.

[00138] Game Server 1425 is optionally operated by a different entity than Video Server System 1420. For example, Game Server 1425 may be operated by the publisher of a multiplayer game. In this example, Video Server System 1420 is optionally viewed as a client by Game Server 1425 and optionally configured to appear from the point of view of Game Server 1425 to be a prior art client executing a prior art game engine. Communication between Video Server System 1420 and Game Server 1425 optionally occurs via Network 1415. As such, Game Server 1425 can be a prior art multiplayer game server that sends game state information to multiple clients, one of which is game server system 1420. Video Server System 1420 may be configured to communicate with multiple instances of Game Server 1425 at the same time. For example, Video Server System 1420 can be configured to provide a plurality of different video games to different users. Each of these different video games may be supported by a different Game Server 1425 and/or published by different entities. In some embodiments, several geographically distributed instances of Video Server System 1420 are configured to provide game video to a plurality of different users. Each of these instances of Video Server System 1420 may be in communication with the same instance of Game Server 1425. Communication between Video Server System 1420 and one or more Game Server 1425 optionally occurs via a dedicated communication channel. For example, Video Server System

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1420 may be connected to Game Server 1425 via a high bandwidth channel that is dedicated to communication between these two systems.

[00139] Video Server System 1420 comprises at least a Video Source 1430, an I/O Device 1445, a Processor 1450, and non-transitory Storage 1455. Video Server System 1420 may include one computing device or be distributed among a plurality of computing devices. These computing devices are optionally connected via a communications system such as a local area network.

[00140] Video Source 1430 is configured to provide a video stream, e.g., streaming video or a series of video frames that form a moving picture. In some embodiments, Video Source 1430 includes a video game engine and rendering logic. The video game engine is configured to receive game commands from a player and to maintain a copy of the state of the video game based on the received commands. This game state includes the position of objects in a game environment, as well as typically a point of view. The game state may also include properties, images, colors and/or textures of objects. The game state is typically maintained based on game rules, as well as game commands such as move, turn, attack, set focus to, interact, use, and/or the like. Part of the game engine is optionally disposed within Game Server 1425. Game Server 1425 may maintain a copy of the state of the game based on game commands received from multiple players using geographically disperse clients. In these cases, the game state is provided by Game Server 1425 to Video Source 1430, wherein a copy of the game state is stored and rendering is performed. Game Server 1425 may receive game commands directly from Clients 1410 via Network 1415, and/or may receive game commands via Video Server System 1420.

[00141] Video Source 1430 typically includes rendering logic, e.g., hardware, firmware, and/or software stored on a computer readable medium such as

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Storage 1455. This rendering logic is configured to create video frames of the video stream based on the game state. All or part of the rendering logic is optionally disposed within a graphics processing unit (GPU). Rendering logic typically includes processing stages configured for determining the three-dimensional spatial relationships between objects and/or for applying appropriate textures, etc., based on the game state and viewpoint. The rendering logic produces raw video that is then usually encoded prior to communication to Clients 1410. For example, the raw video may be encoded according to an Adobe Flash® standard, .wav, H.264, H.263, On2, VP6, VC-1, WMA, Huffyuv, Lagarith, MPG-x. Xvid. FFmpeg, x264, VP6-8, realvideo, mp3, or the like. The encoding process produces a video stream that is optionally packaged for delivery to a decoder on a remote device. The video stream is characterized by a frame size and a frame rate. Typical frame sizes include 800 x 600, 1280 x 720 (e.g., 720p), 1024 x 768, although any other frame sizes may be used. The frame rate is the number of video frames per second. A video stream may include different types of video frames. For example, the H.264 standard includes a "P" frame and a "I" frame. I-frames include information to refresh all macro blocks/pixels on a display device, while P-frames include information to refresh a subset thereof. P-frames are typically smaller in data size than are I-frames. As used herein the term "frame size" is meant to refer to a number of pixels within a frame. The term "frame data size" is used to refer to a number of bytes required to store the frame.

[00142] In alternative embodiments Video Source 1430 includes a video recording device such as a camera. This camera may be used to generate delayed or live video that can be included in the video stream of a computer game. The resulting video stream, optionally includes both rendered images and images recorded using a still or video camera. Video Source 1430 may also include storage devices configured

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to store previously recorded video to be included in a video stream. Video Source 1430 may also include motion or positioning sensing devices configured to detect motion or position of an object, e.g., person, and logic configured to determine a game state or produce video-based on the detected motion and/or position.

[00143] Video Source 1430 is optionally configured to provide overlays configured to be placed on other video. For example, these overlays may include a command interface, log in instructions, messages to a game player, images of other game players, video feeds of other game players (e.g., webcam video). In embodiments of Client 1410A including a touch screen interface or a gaze detection interface, the overlay may include a virtual keyboard, joystick, touch pad, and/or the like. In one example of an overlay a player's voice is overlaid on an audio stream. Video Source 1430 optionally further includes one or more audio sources.

[00144] In embodiments wherein Video Server System 1420 is configured to maintain the game state based on input from more than one player, each player may have a different point of view comprising a position and direction of view. Video Source 1430 is optionally configured to provide a separate video stream for each player based on their point of view. Further, Video Source 1430 may be configured to provide a different frame size, frame data size, and/or encoding to each of Client 1410. Video Source 1430 is optionally configured to provide 3-D video.

[00145] I/O Device 1445 is configured for Video Server System 1420 to send and/or receive information such as video, commands, requests for information, a game state, gaze information, device motion, device location, user motion, client identities, player identities, game commands, security information, audio, and/or the like. I/O Device 1445 typically includes communication hardware such as a network

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card or modem. I/O Device 1445 is configured to communicate with Game Server 1425, Network 1415, and/or Clients 1410.

[00146] Processor 1450 is configured to execute logic, e.g. software, included within the various components of Video Server System 1420 discussed herein. For example, Processor 1450 may be programmed with software instructions in order to perform the functions of Video Source 1430, Game Server 1425, and/or a Client Qualifier 1460. Video Server System 1420 optionally includes more than one instance of Processor 1450. Processor 1450 may also be programmed with software instructions in order to execute commands received by Video Server System 1420, or to coordinate the operation of the various elements of Game System 1400 discussed herein. Processor 1450 may include one or more hardware device. Processor 1450 is an electronic processor.

[00147] Storage 1455 includes non-transitory analog and/or digital storage devices. For example, Storage 1455 may include an analog storage device configured to store video frames. Storage 1455 may include a computer readable digital storage, e.g. a hard drive, an optical drive, or solid state storage. Storage 1415 is configured (e.g. by way of an appropriate data structure or file system) to store video frames, artificial frames, a video stream including both video frames and artificial frames, audio frame, an audio stream, and/or the like. Storage 1455 is optionally distributed among a plurality of devices. In some embodiments, Storage 1455 is configured to store the software components of Video Source 1430 discussed elsewhere herein. These components may be stored in a format ready to be provisioned when needed.

[00148] Video Server System 1420 optionally further comprises Client Qualifier 1460. Client Qualifier 1460 is configured for remotely determining the capabilities of a client, such as Clients 1410A or 1410B. These capabilities can

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include both the capabilities of Client 1410A itself as well as the capabilities of one or more communication channels between Client 1410A and Video Server System 1420. For example, Client Qualifier 1460 may be configured to test a communication channel through Network 1415.

[00149] Client Qualifier 1460 can determine (e.g., discover) the capabilities of Client 1410A manually or automatically. Manual determination includes communicating with a user of Client 1410A and asking the user to provide capabilities. For example, in some embodiments, Client Qualifier 1460 is configured to display images, text, and/or the like within a browser of Client 1410A. In one embodiment, Client 1410A is an HMD that includes a browser. In another embodiment, client 1410A is a game console having a browser, which may be displayed on the HMD. The displayed objects request that the user enter information such as operating system, processor, video decoder type, type of network connection, display resolution, etc. of Client 1410A. The information entered by the user is communicated back to Client Qualifier 1460.

[00150] Automatic determination may occur, for example, by execution of an agent on Client 1410A and/or by sending test video to Client 1410A. The agent may comprise computing instructions, such as java script, embedded in a web page or installed as an add-on. The agent is optionally provided by Client Qualifier 1460. In various embodiments, the agent can find out processing power of Client 1410A, decoding and display capabilities of Client 1410A, lag time reliability and bandwidth of communication channels between Client 1410A and Video Server System 1420, a display type of Client 1410A, firewalls present on Client 1410A, hardware of Client 1410A, software executing on Client 1410A, registry entries within Client 1410A, and/or the like.

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[00151] Client Qualifier 1460 includes hardware, firmware, and/or software stored on a computer readable medium. Client Qualifier 1460 is optionally disposed on a computing device separate from one or more other elements of Video Server System 1420. For example, in some embodiments, Client Qualifier 1460 is configured to determine the characteristics of communication channels between Clients 1410 and more than one instance of Video Server System 1420. In these embodiments the information discovered by Client Qualifier can be used to determine which instance of Video Server System 1420 is best suited for delivery of streaming video to one of Clients 1410.

[00152] Embodiments of the present disclosure may be practiced with various computer system configurations including hand-held devices, microprocessor systems, microprocessor-based or programmable consumer electronics, minicomputers, mainframe computers and the like. The disclosure can also be practiced in distributed computing environments where tasks are performed by remote processing devices that are linked through a wire-based or wireless network.

[00153] With the above embodiments in mind, it should be understood that the disclosure can employ various computer-implemented operations involving data stored in computer systems. These operations are those requiring physical manipulation of physical quantities. Any of the operations described herein that form part of the disclosure are useful machine operations. The disclosure also relates to a device or an apparatus for performing these operations. The apparatus can be specially constructed for the required purpose, or the apparatus can be a general-purpose computer selectively activated or configured by a computer program stored in the computer. In particular, various general-purpose machines can be used with computer programs written in accordance with the teachings herein, or it may be more

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convenient to construct a more specialized apparatus to perform the required operations.

[00154] The disclosure can also be embodied as computer readable code on a computer readable medium. The computer readable medium is any data storage device that can store data, which can thereafter be read by a computer system. Examples of the computer readable medium include hard drives, network attached storage (NAS), read-only memory, random-access memory, CD-ROMs, CD-Rs, CD-RWs, magnetic tapes and other optical and non-optical data storage devices. The computer readable medium can include computer readable tangible medium distributed over a network-coupled computer system so that the computer readable code is stored and executed in a distributed fashion.

[00155] Although the method operations were described in a specific order, it should be understood that other housekeeping operations may be performed in between operations, or operations may be adjusted so that they occur at slightly different times, or may be distributed in a system which allows the occurrence of the processing operations at various intervals associated with the processing, as long as the processing of the overlay operations are performed in the desired way.

[00156] Although the foregoing disclosure has been described in some detail for purposes of clarity of understanding, it will be apparent that certain changes and modifications can be practiced within the scope of the appended claims. Accordingly, the present embodiments are to be considered as illustrative and not restrictive, and the disclosure is not to be limited to the details given herein, but may be modified within the scope and equivalents of the present disclosure.

What is claimed is:

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CLAIMS

1. A method for generating views of a virtual reality environment for a spectator, comprising,

generating a virtual reality environment to be rendered for a head mounted display (HMD) of an HMD player, the HMD player being provided with an HMD view that is controlled by movement of the HMD by the HMD player; and

providing a spectator view into the virtual reality environment, the spectator view being associated with a viewing spot directed into the virtual reality environment, the viewing spot is decoupled from the HMD view.

2. The method of claim 1, wherein movement of the HMD changes the HMD view, and wherein having the viewing spot of the spectator view decoupled produces a delayed movement of the viewing spot to follow the HMD view.

3. The method of claim 2, wherein the delayed movement of the viewing spot functions to follow the HMD view at a slower rate than movements of the HMD.

4. The method of claim 1,wherein the viewing spot is one of a plurality of viewing spots associated with the virtual reality environment.

5. The method of claim 4, wherein select ones of the viewing spots are selected for the spectator view.

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6. The method of claim 4, wherein select ones of the viewing spots are selected for the spectator based on specific content identified to be interesting in the virtual reality environment.

7. The method of claim 1, wherein the spectator view is part of the HMD view.

8. The method of claim 1, wherein the spectator view is greater than the HMD view.

9. The method of claim 1, wherein a gaze direction of the HMD player is used to identify content being viewed by the HMD player to the spectator.

10. The method of claim 1, further comprising,

receiving selection of a listening zone in the virtual reality environment by the spectator, wherein selection of the listening zone provides audio to the spectator from a perspective of the listening zone.

11. A method executed by a server for generating views of a virtual reality environment for a spectator, comprising,

receiving, by the server, a feed of a virtual reality environment rendered for a head mounted display (HMD) of an HMD player, the HMD player being provided with an HMD view that is controlled by movement of the HMD by the HMD player, the feed of the virtual reality environment being shared to a website;

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receiving, by the server, a request from the spectator to access the virtual reality environment from the website; and

sending, by the server, a spectator view into the virtual reality environment to a device of the spectator, the spectator view being associated with a viewing spot directed into the virtual reality environment, the viewing spot is decoupled from the HMD view;

wherein the spectator view is updated to other viewing spots directed into the virtual reality environment as the HMD player moves around the virtual reality environment.

12. The method of claim 11, wherein the viewing spots are pre-authored viewing spots that are selected to provide interesting views into the virtual reality environment as the HMD player traverses the virtual reality environment.

13. The method of claim 11, wherein spectator is popped from one to another of the pre-authored viewing spots.

14. The method of claim 11, wherein a profile of the spectator identifies a preference for a type of view or content, and the preference is used to select which ones of the pre-authored viewing spots are provided to the spectator.

15. The method of claim 11, wherein the device of the spectator is one of an HMD used by the spectator or a television screen used by the spectator, or a computer screen used by the spectator, or hand-held device screen used by the spectator.

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16. The method of claim 11, wherein the spectator is one of a plurality of spectators that provides access to view the HMD view of the HMD player.

17. The method of claim 11, wherein the website provides a selection of options of other HMD views of other HMD players, such that the spectator can select specific ones of the HMD views and see the respective virtual reality environments from one or more spectator views.

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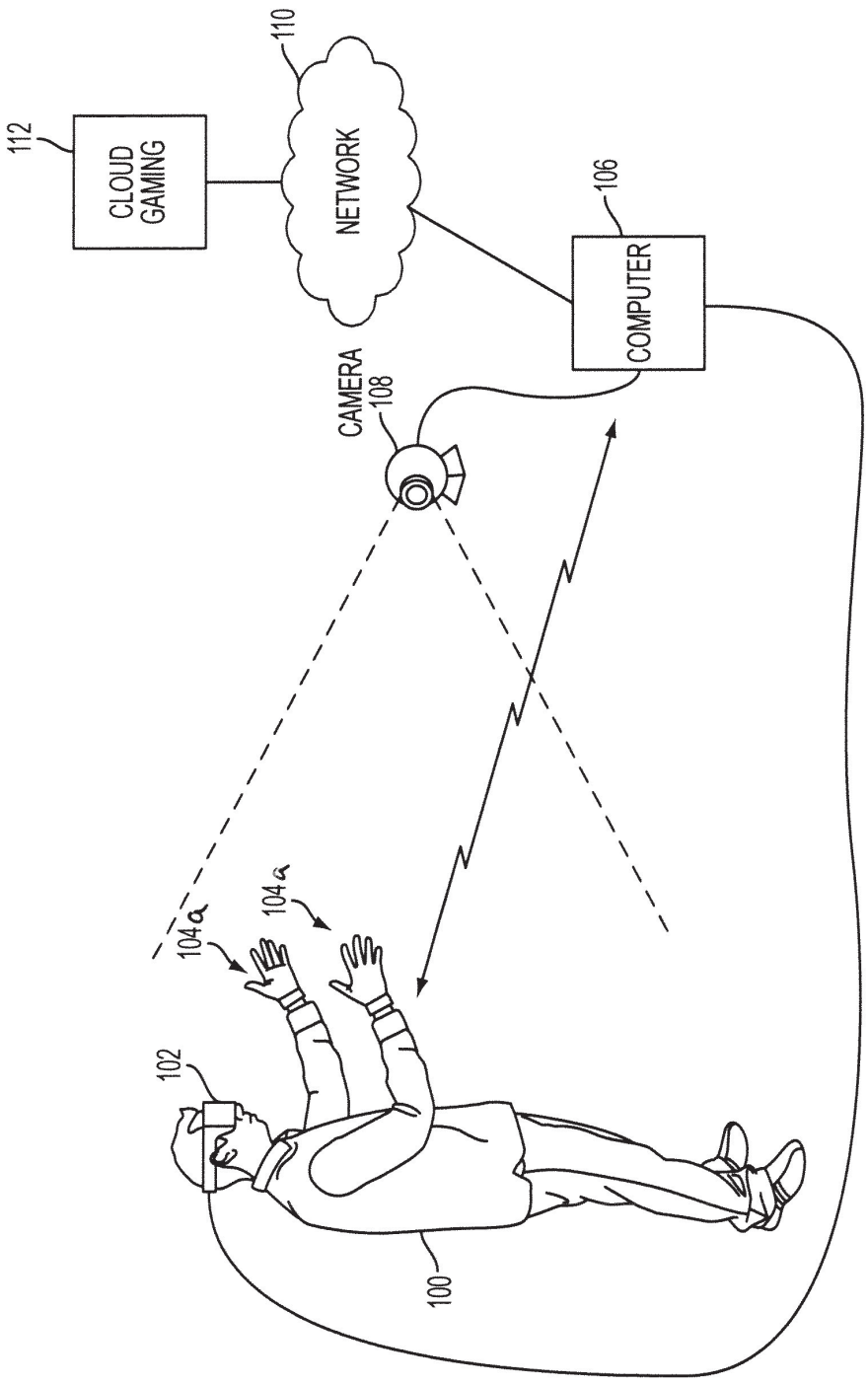

112
CLOUD GAMING
110
NETWORK
106
COMPUTER
CAMERA
108
104a
104a
102
100

FIG. 1

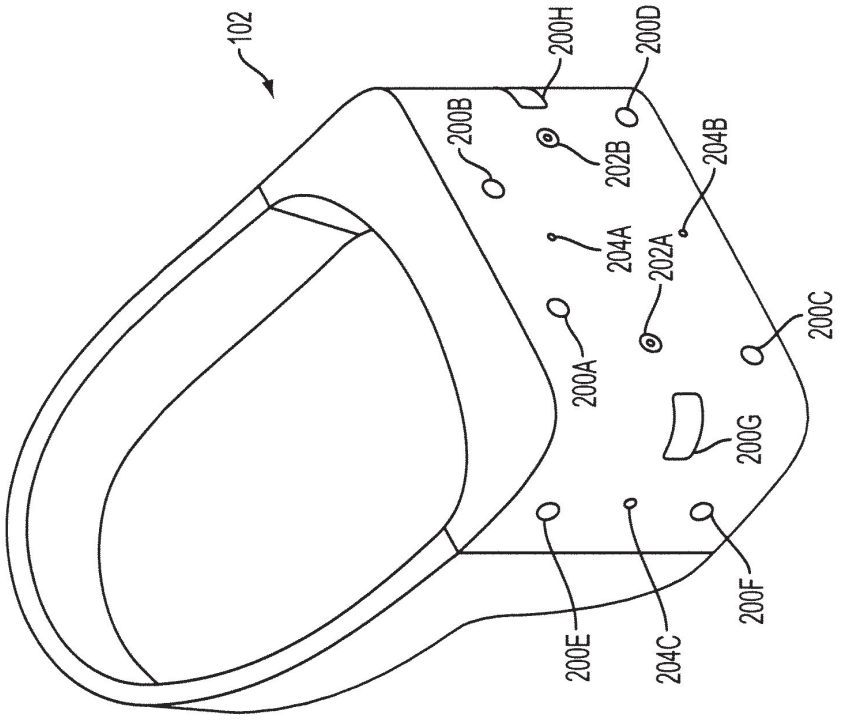

102
200H
200D
200B
202B
204B
204A
202A
200A
200C
200G
200E
204C
200F

FIG. 2A

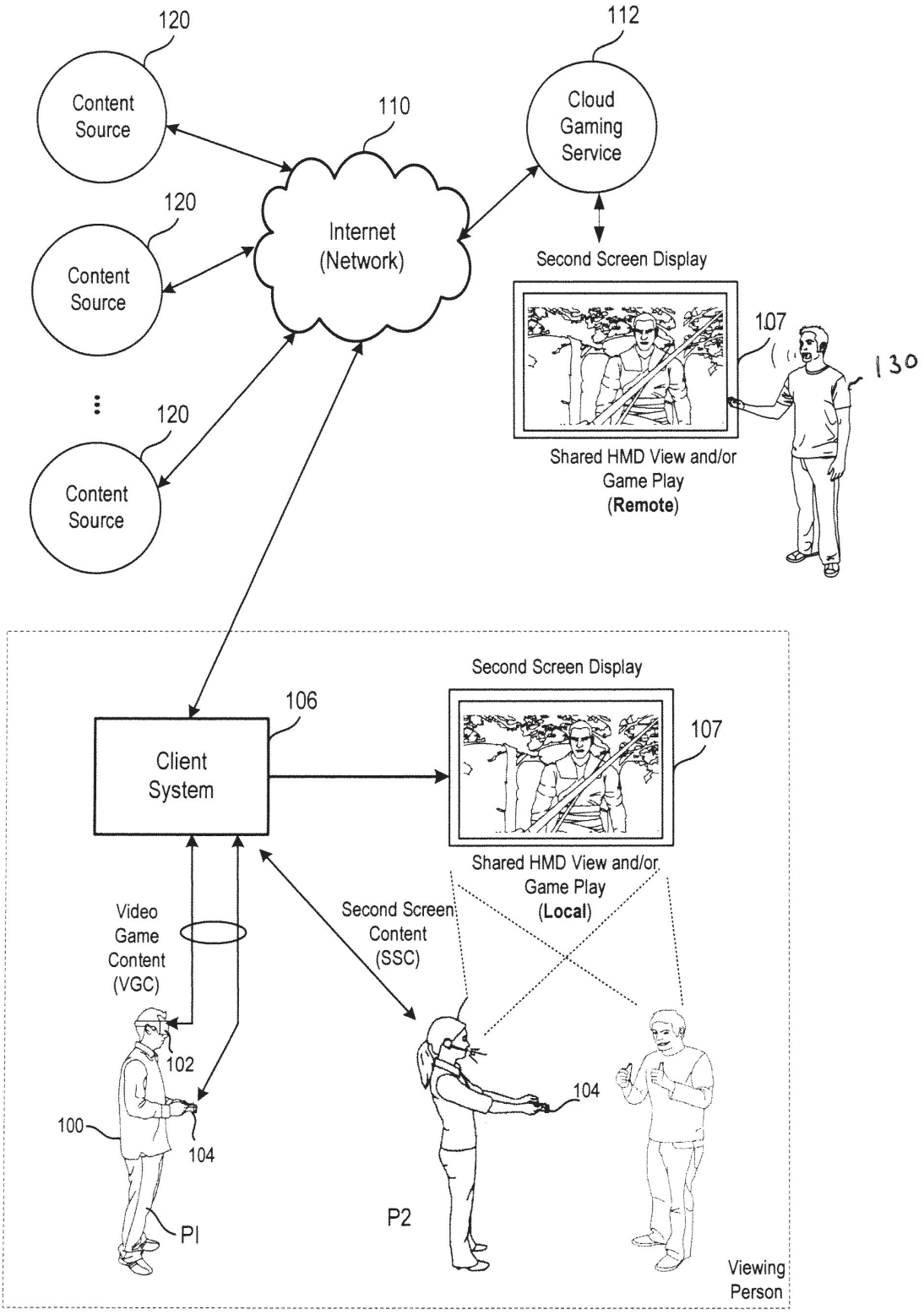

120
Content Source
120
Content Source
120
Content Source
110
Internet (Network)
112
Cloud Gaming Service
Second Screen Display
107
130
Shared HMD View and/or Game Play (Remote)
Second Screen Display
106
Client System
107
Shared HMD View and/or Game Play (Local)
Video Game Content (VGC)
Second Screen Content (SSC)
102
100
104
PI
104
P2
Viewing Person

FIG. 2B

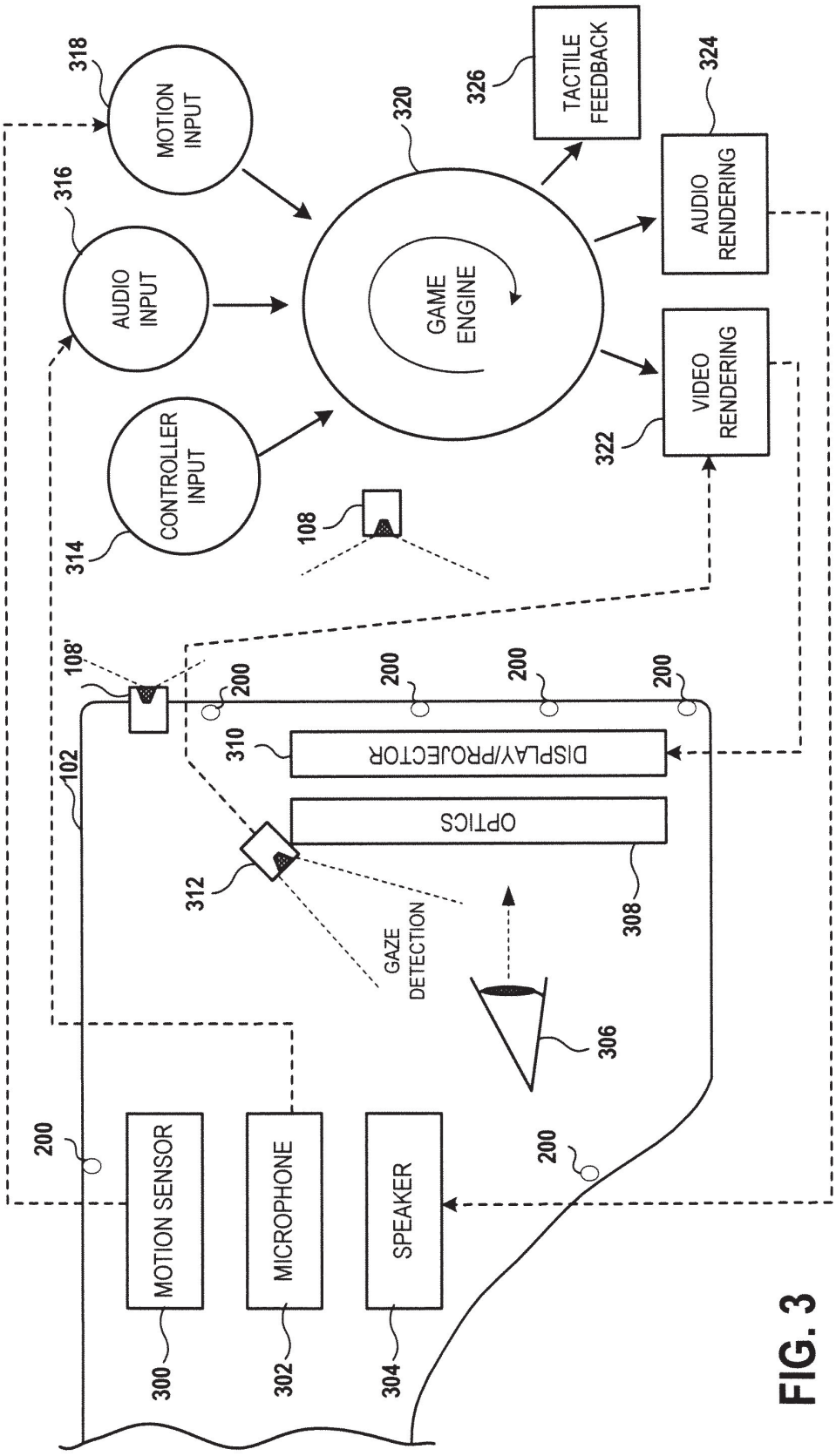

MOTION INPUT
318
AUDIO INPUT
316
CONTROLLER INPUT
314
GAME ENGINE
320
TACTILE FEEDBACK
326
AUDIO RENDERING
324
VIDEO RENDERING
322
108
108'
200
200
200
200
102
DISPLAY/PROJECTOR
310
OPTICS
308
312
GAZE DETECTION
306
MOTION SENSOR
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MICROPHONE
302
SPEAKER
304
200
200

FIG. 3

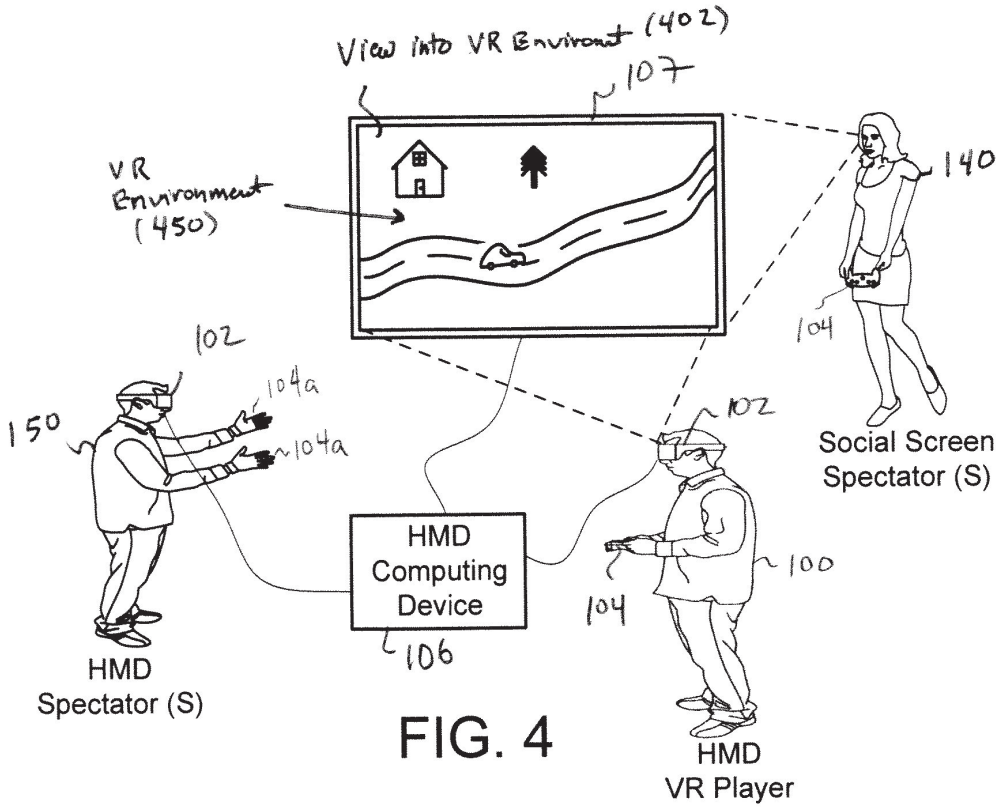

View into VR Environment (402)
107
VR Environment (450)
140
104
102
104a
104a
150
102
Social Screen Spectator (S)
HMD Computing Device
106
100
104
HMD Spectator (S)
HMD VR Player

FIG. 4

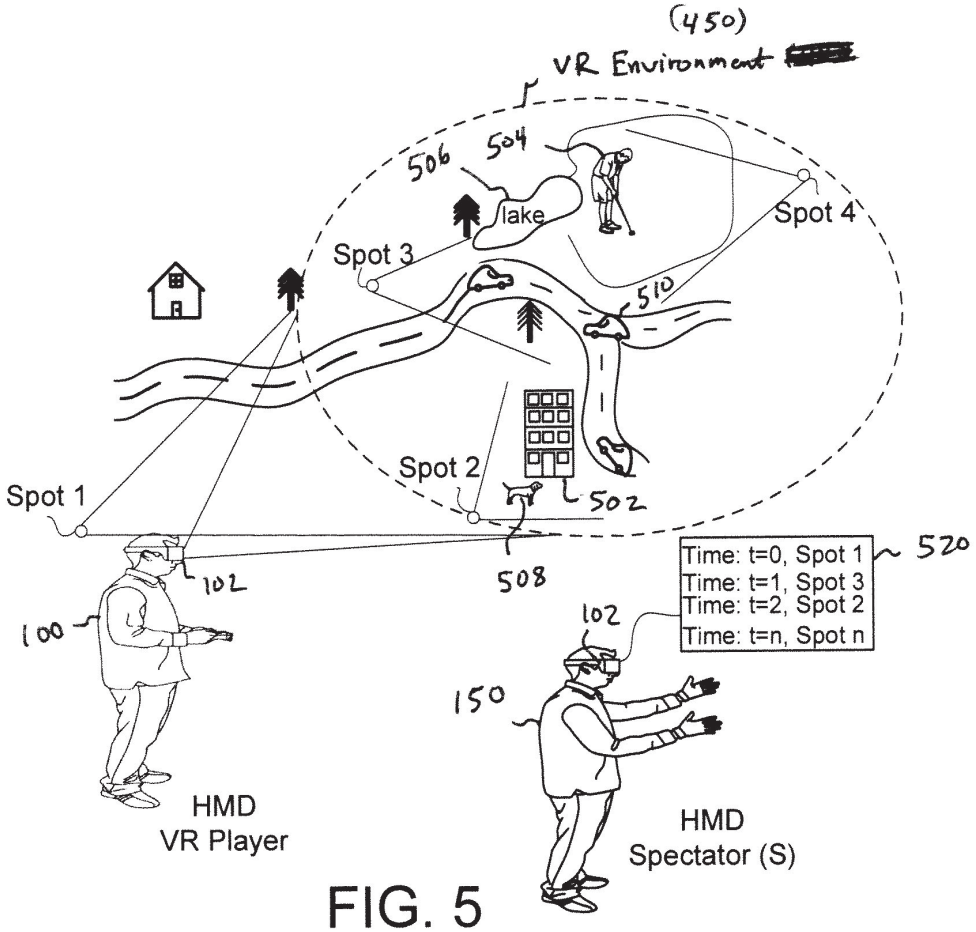

(450)
VR Environment
506
504
lake
Spot 4
Spot 3
510
Spot 2
502
Spot 1
508
520
Time: t=0, Spot 1
Time: t=1, Spot 3
Time: t=2, Spot 2
Time: t=n, Spot n
102
100
102
150
HMD VR Player
HMD Spectator (S)

FIG. 5

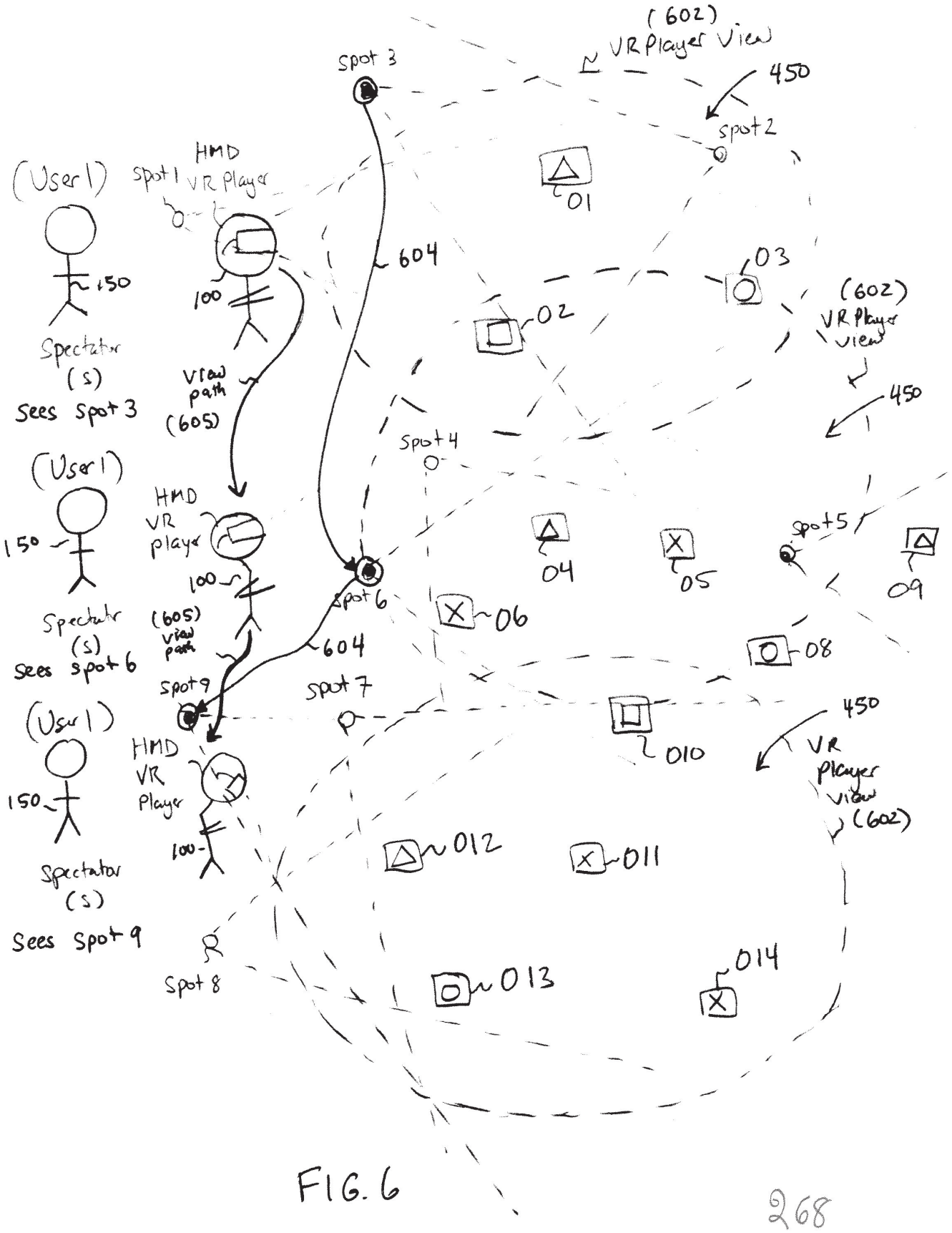

(602)
VR Player View
450
spot 3
spot 2
HMD
spot 1 VR Player
(User 1)
150
100
Spectator
(s)
Sees spot 3
View path
(605)
604
01
03
02
(602)
VR Player
View
450
spot 4
spot 5
09
04
05
(User 1)
HMD
VR
player
150
100
spot 6
06
08
(605)
view
path
604
spot 9
spot 7
010
(User 1)
450
VR
player
view
(602)
HMD
VR
Player
150
100
012
011
Spectator
(s)
Sees spot 9
Spot 8
013
014

FIG. 6

268

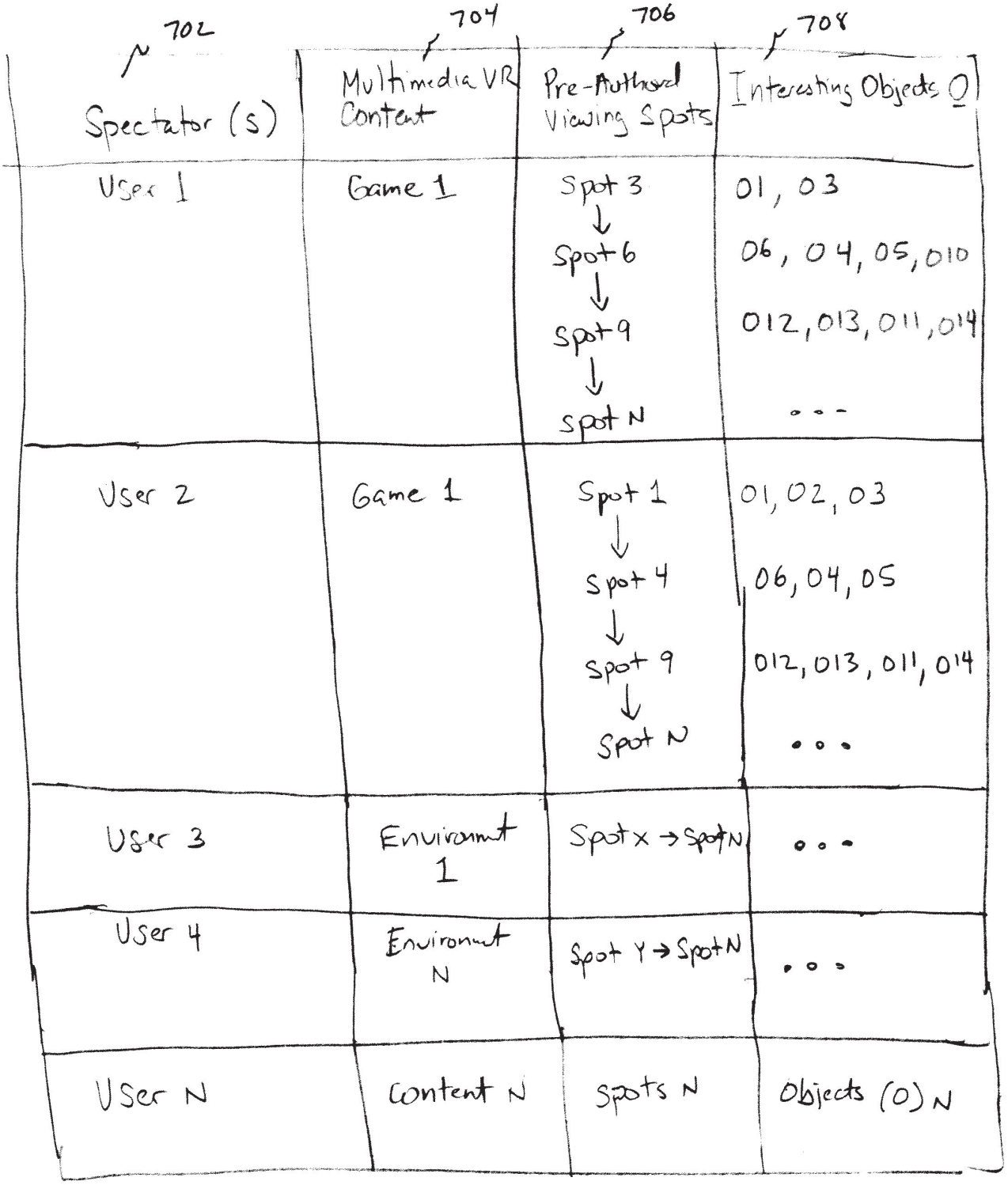
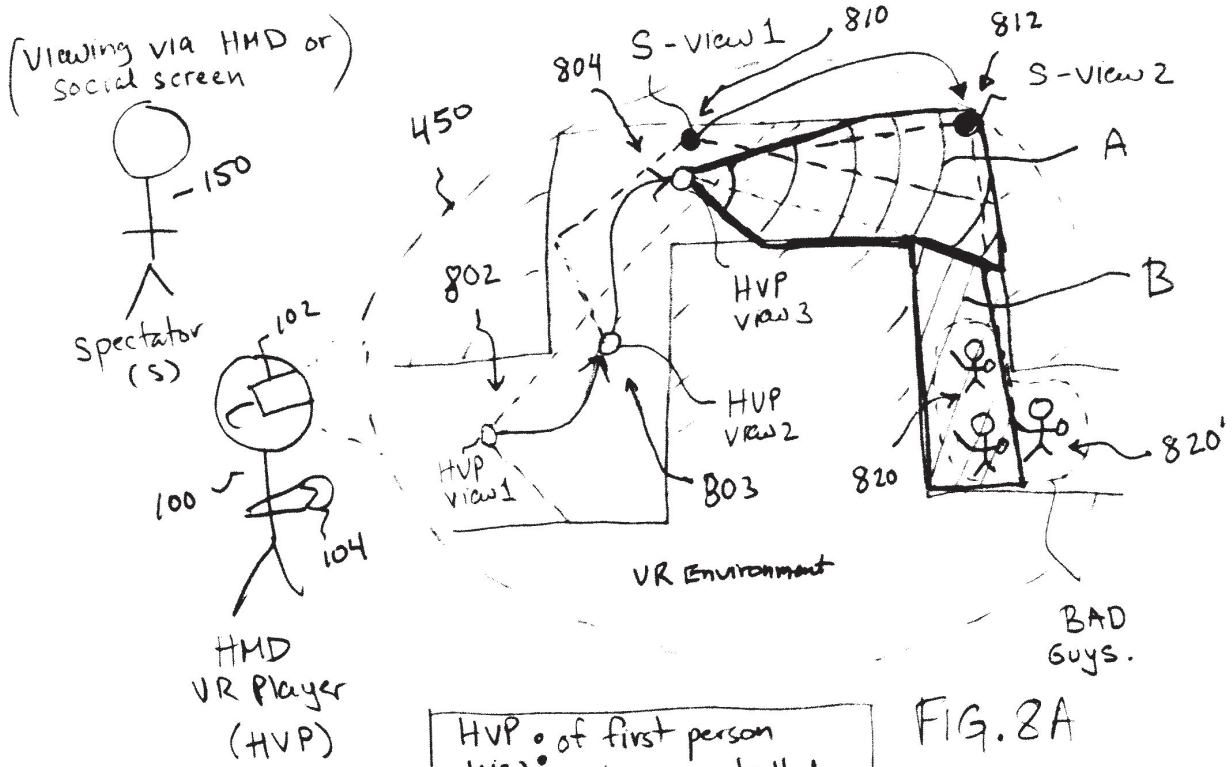


FIG. 7

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HVP = of first person view = player controlled by HMD VR Player

FIG. 8A

830 HMD VR Player	832 Spectator (s) View Position	834 HMD VR Player sees	836 Spectator (s) sees	838 Spectator (s) Sees more than HVP
HVP View 1	S-View 1	HVP View 1	HVP View 1	HVP view 1
HVP View 2	S-View 1	HVP View 2	HVP View 2	HVP view 2
HVP View 3	S-View 2	HVP View 3 (A)	HVP View 3 (A)	Also Sees B A+B

FIG. 8B

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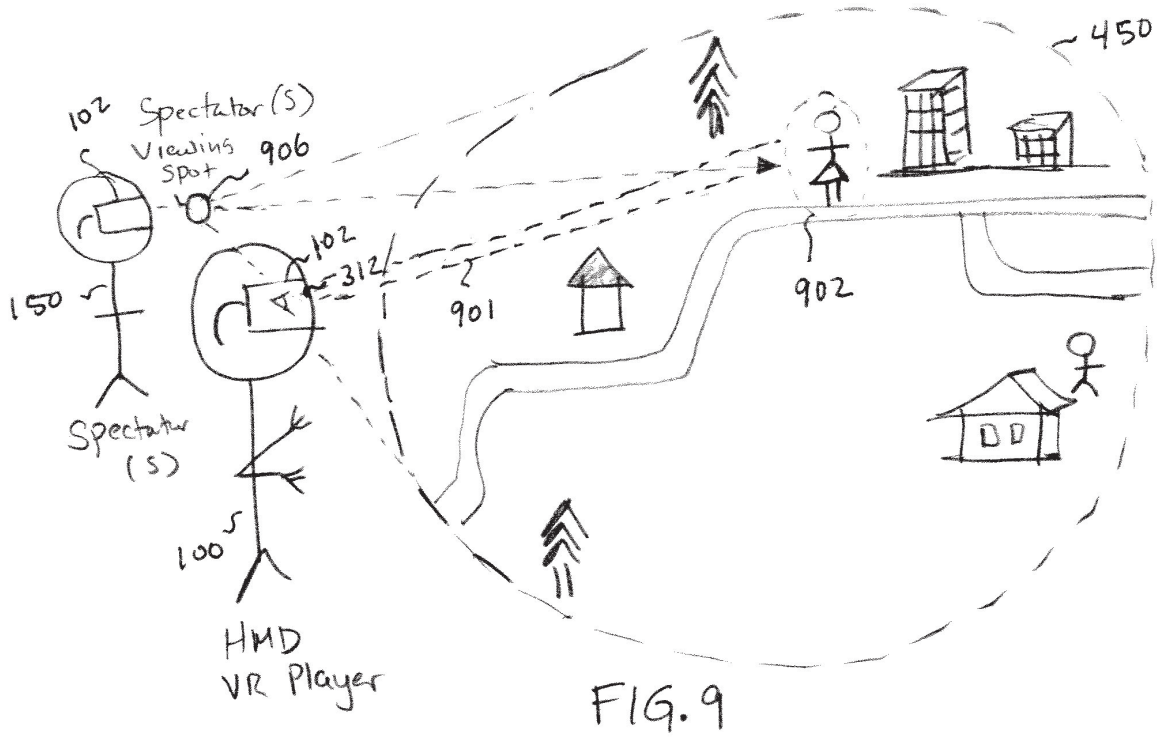


FIG. 9

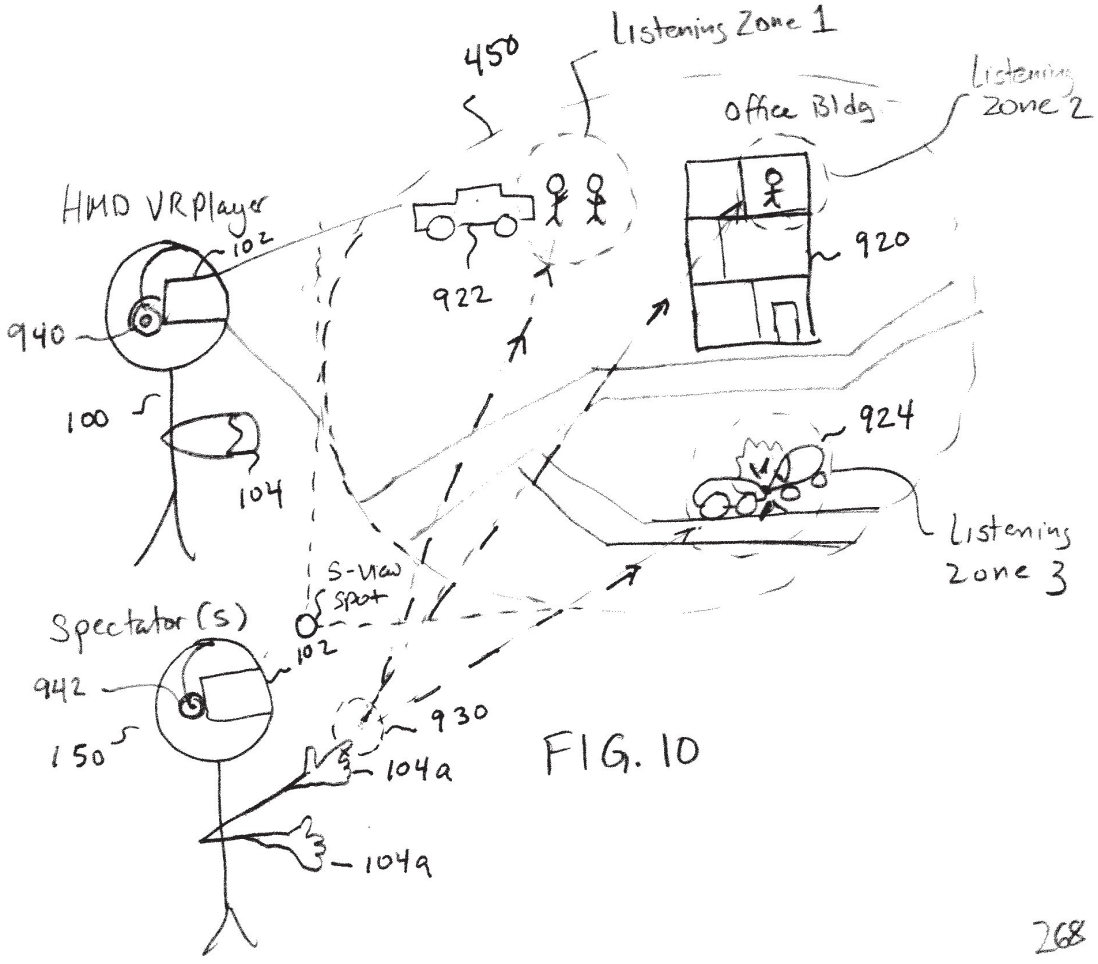


FIG. 10

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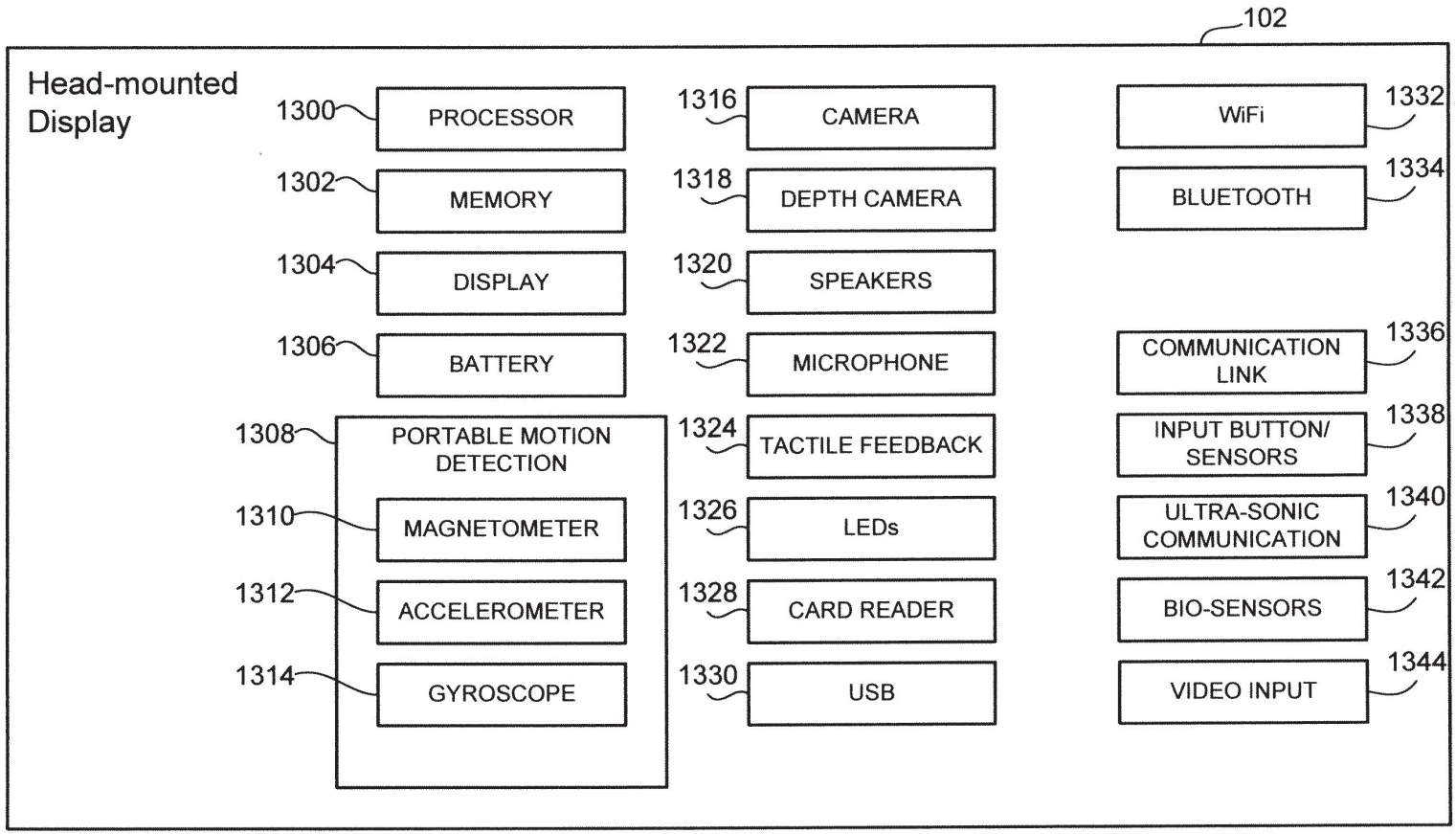


FIG. 11

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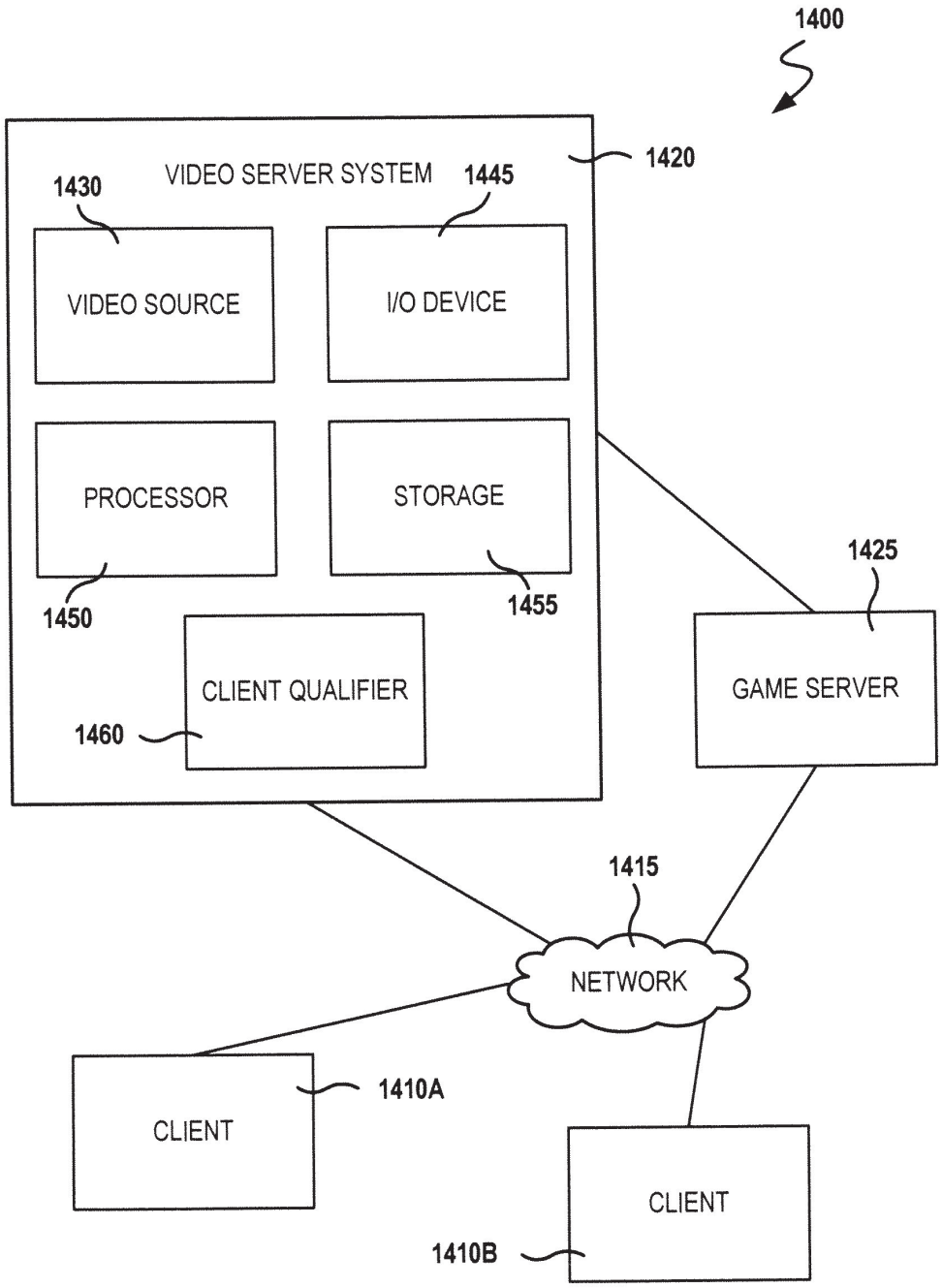

1400
VIDEO SERVER SYSTEM
1420
1430
1445
VIDEO SOURCE
I/O DEVICE
PROCESSOR
STORAGE
1450
1455
CLIENT QUALIFIER
1460
1425
GAME SERVER
1415
NETWORK
CLIENT
1410A
CLIENT
1410B

FIG. 12