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CONFIRMATION NO. 9556

FILING RECEIPT

16051
MPG, LLP and SONY
710 Lakeway Drive, Suite 200
Sunnyvale, CA 94085

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Date Mailed: 04/04/2016

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The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 62/309,882**

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Early Publication Request: No

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Title

Spectating Virtual Reality (VR) Environments Associated With VR User Interactivity

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Document Description: Provisional Cover Sheet (SB16)

PTO/SB/16 (11-08)
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Provisional Application for Patent Cover Sheet

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c)

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All Inventors Must Be Listed – Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. — Add

Title of Invention	Spectating Virtual Reality (VR) Environments Associated With VR User Interactivity
Attorney Docket Number (if applicable)	SONYP268+

Correspondence Address

Direct all correspondence to (select one):

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- Yes, the invention was made by an agency of the United States Government. The U.S. Government agency name is:
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Entity Status
Applicant asserts small entity status under 37 CFR 1.27 or applicant certifies micro entity status under 37 CFR 1.29

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Signature	/Albert Penilla/			Date (YYYY-MM-DD)	2016-03-17
First Name	Albert	Last Name	Penilla	Registration Number (If appropriate)	39487

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SPECTATING VIRTUAL REALITY (VR) ENVIRONMENTS ASSOCIATED WITH VR USER INTERACTIVITY

ABSTRACT OF THE DISCLOSURE

A method, system, computer readable media and cloud systems are provided for generating views of a virtual reality environment for a spectator. One example method includes generating a virtual reality environment to be rendered for a head mounted display (HMD) of an HMD player. The HMD player is provided with an HMD view that is controlled by movement of the HMD by the HMD player. Then, providing a spectator view into the virtual reality environment. The spectator view is associated with a viewing spot directed into the virtual reality environment. The viewing spot is decoupled from the HMD view. In some examples, multiple viewing spots are pre-authored and the spectator is provided with different ones of the viewing spots as the HMD players move around the virtual reality environment.

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Attorney Docket No. SONYP268+

PATENT APPLICATION

SPECTATING VIRTUAL REALITY (VR) ENVIRONMENTS ASSOCIATED WITH VR USER INTERACTIVITY

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SPECTATING VIRTUAL REALITY (VR) ENVIRONMENTS ASSOCIATED WITH VR USER INTERACTIVITY

by Inventors:
Richard Marks
Steven Osman

CLAIM OF PRIORITY

1. Field of the Disclosure

[0001] The present disclosure relates to virtual reality (VR) environment content presented in head mounted displays (HMDs), and methods and systems for integrating access to VR environments by spectating users and methods for enabling users to spectate dynamically changing environments being navigated by HMD users that interact in VR environments, and associated apparatus and methods.

BACKGROUND

2. Description of the Related Art

[0002] The video game industry has seen many changes over the years. As computing power has expanded, developers of video games have likewise created game software that takes advantage of these increases in computing power. To this end, video game developers have been coding games that incorporate sophisticated operations and mathematics to produce very detailed and engaging gaming experiences.

[0003] Example gaming platforms include the Sony Playstation®, Sony Playstation2® (PS2), Sony Playstation3® (PS3), and Sony Playstation4® (PS4), each of which is sold in the form of a game console. As is well known, the game console

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is designed to connect to a display (typically a television) and enable user interaction through handheld controllers. The game console is designed with specialized processing hardware, including a CPU, a graphics synthesizer for processing intensive graphics operations, a vector unit for performing geometry transformations, and other glue hardware, firmware, and software. The game console may be further designed with an optical disc reader for receiving game discs for local play through the game console. Online gaming is also possible, where a user can interactively play against or with other users over the Internet. As game complexity continues to intrigue players, game and hardware manufacturers have continued to innovate to enable additional interactivity and computer programs.

[0004] A growing trend in the computer gaming industry is to develop games that increase the interaction between the user and the gaming system. One way of accomplishing a richer interactive experience is to use wireless game controllers whose movement is tracked by the gaming system in order to track the player's movements and use these movements as inputs for the game. Generally speaking, gesture input refers to having an electronic device such as a computing system, video game console, smart appliance, etc., react to some gesture made by the player and captured by the electronic device.

[0005] Another way of accomplishing a more immersive interactive experience is to use a head-mounted display. A head-mounted display is worn by the user and can be configured to present various graphics, such as a view of a virtual space. The graphics presented on a head-mounted display can cover a large portion or even all of a user's field of view. Hence, a head-mounted display can provide a visually immersive experience to the user.

[0006] It is in this context that embodiments of the disclosure arise.

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SUMMARY

[0007] Implementations of the present disclosure include methods and systems that are used for enabling spectating virtual reality environments and content being encountered, viewed and/or interfaced with by HMD users. In some embodiments, methods and systems are described that enable users to spectate in a VR user's VR environment via pre-authored spots/locations in the virtual reality space. In another embodiment, a spectating mode enables a user to use a VR user's gaze direction to focus or identify specific locations within VR environment. By way of example, a gaze direction of the VR user can identify some location within the VR environment that the spectator can identify. In another embodiment, audio controls are adjusted and/or modified to enable a spectator to focus his listening to specific locations within VR environment of VR user. For example, the spectating user can decide that some location within the VR environment is interesting, and sounds to the spectating user can then be adjusted to provide the spectating user sounds that would surround the spectating user, as if the spectating user is actually located at that identified VR environment location.

[0008] In one embodiment, a method for generating views of a virtual reality environment for a spectator is provided. The method includes generating a virtual reality environment to be rendered for a head mounted display (HMD) of an HMD player. The HMD player is provided with an HMD view that is controlled by movement of the HMD by the HMD player. Then, providing a spectator view into the virtual reality environment. The spectator view is associated with a viewing spot directed into the virtual reality environment. The viewing spot is decoupled from the HMD view. In some examples, multiple viewing spots are pre-authored and the

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spectator is provided with different ones of the viewing spots as the HMD players move around the virtual reality environment.

[0009] In some embodiments, 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.

[0010] In some embodiments, the delayed movement of the viewing spot function to follow the HMD view at a slower rate than movements of the HMD.

[0011] In some embodiments, the viewing spot is one of a plurality of viewing spots associated with the virtual reality environment.

[0012] In some embodiments, select ones of the viewing spots are selected for the spectator view.

[0013] In some embodiments, select ones of the viewing spots are selected for the spectator based on specific content identified to be interesting in the virtual reality environment.

[0014] In some embodiments, the spectator view is part of the HMD view.

[0015] In some embodiments, the spectator view is greater than the HMD view.

[0016] In some embodiments, a gaze direction of the HMD player is used to identify content being viewed by the HMD player to the spectator.

[0017] In some embodiments, the method further includes 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.

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[0018] In another embodiment, a method executed by a server for generating views of a virtual reality environment for a spectator is provided. The method includes 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 is provided with an HMD view that is controlled by movement of the HMD by the HMD player. The feed of the virtual reality environment is shared to a website. The method also includes receiving, by the server, a request from the spectator to access the virtual reality environment from the website. Then, sending, by the server, a spectator view into the virtual reality environment to a device of the spectator. The spectator view is associated with a viewing spot directed into the virtual reality environment, and the viewing spot is decoupled from the HMD view. 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.

[0019] In some embodiments, 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.

[0020] In some embodiments, spectator is popped from one to another of the pre-authored viewing spots.

[0021] In some embodiments, 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.

[0022] In some embodiments, 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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[0023] In some embodiments, the spectator is one of a plurality of spectators that provides access to view the HMD view of the HMD player.

[0024] In some embodiments, 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.

[0025] Other aspects and advantages of the disclosure will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the disclosure.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0026] The disclosure may be better understood by reference to the following description taken in conjunction with the accompanying drawings in which:

[0027] Figure 1 illustrates a system for interactive gameplay of a video game, in accordance with an embodiment of the disclosure.

[0028] Figure 2A illustrates a head-mounted display (HMD), in accordance with an embodiment of the disclosure.

[0029] Figure 2B illustrates one example of an HMD user interfacing with a client system, and the client system providing content to a second screen display, which is referred to as a second screen, in accordance with one embodiment.

[0030] Figure 3 conceptually illustrates the function of an HMD in conjunction with an executing video game, in accordance with an embodiment of the disclosure.

[0031] Figure 4 illustrates an example of an HMD player navigating a virtual reality environment, and one or more spectators viewing the virtual-reality content.

[0032] Figure 5 illustrates an example of an HMD player navigating the virtual reality environment, and an HMD spectator being provided with different viewing spots within the virtual-reality environment, which can be selected or pre-authored based on interesting content within the virtual-reality scene.

[0033] Figure 6 illustrates an example of an HMD player navigating through the virtual reality environment and the automatic selection of viewing spots

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for a spectator, where the viewing spots are automatically selected based on the preferences of the spectating user, in accordance with one embodiment.

[0034] Figure 7 illustrates an example of how different spectators can be provided with different pre-authored viewing spots into multimedia VR content, and association of interesting objects to be viewed from the perspective of specific viewing spots, in accordance with one embodiment.

[0035] Figures 8A-8B illustrates an example of a virtual reality environment that includes a gaming area, where an HMD player can navigate and be provided with specific player reviews, and spectators that can be provided with views of the environment which include the views of the HMD player and optionally additional views that are not viewable by the HMD player, in accordance with one embodiment.

[0036] Figure 9 illustrates an example where an HMD player can be viewing a specific content or item within a virtual reality environment, and the viewing direction or object being viewed by the HMD player can be identified for a spectator, in accordance with one embodiment.

[0037] Figure 10 illustrates an example where the virtual-reality environment being viewed by the HMD player can include various types of content, which themselves can include different types of audio that is associated to the specific locations within the virtual-reality environment, and allowing a spectator to decide which audio listening location to capture, while spectating, in accordance with one embodiment.

[0038] Figure 11 illustrates components of a head-mounted display, in accordance with an embodiment of the disclosure.

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[0039] Figure 12 is a block diagram of a Game System 1400, according to various embodiments of the disclosure.

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DETAILED DESCRIPTION

[0040] The following implementations of the present disclosure provide methods, systems, computer readable media and cloud systems, for providing spectators of HMD players customized views that improve the experience of spectators. In one embodiment, spectators are provided with the ability to select a particular virtual reality (VR) environment to view, e.g., such as one being generated in response to an HMD player. Spectators, in one embodiment, are provided with new views and perspectives into the virtual reality environment, which may be pre-authored. Pre-authoring of virtual reality viewing spots within the virtual reality environment can facilitate spectators to view or focus on interesting content within the virtual reality scene, as navigated by an HMD player. In one embodiment, more than one viewing spot can be pre-authored within different locations in areas of a game, content, multimedia, or generally content being navigated by the HMD player. These views can be preselected, and assigned to the spectator based on the navigation by the HMD player.

[0041] In one embodiment, these views can be provided in a smooth presentation format, which are not hard-tied or locked to the exact viewing direction of the HMD player. Furthermore, the views provided to spectators can also be provided in such a way that prevents fast movements of the content to the spectators, as would be typical if the same exact view generated by the HMD player were to be shown to the spectator. Because the spectator is not controlling the view in the virtual reality scene, if the spectator's view were tied directly to the HMD player, the content presented to the spectator would have periods of fast movement, such as when the HMD player moves his or her head up down to the right or in different directions. In

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one configuration, the spectator views can follow the movements of the HMD player, but with a smoother delay, so as to prevent this orientation of the spectator. In other embodiments, the spectator views can be fixed to different locations within the virtual reality environment. These fixed locations can be predefined spots that are selected by the content developer, as potentially being interesting to the spectator. In an alternate embodiment, the spots can move, e.g., to follow the HMD player.

[0042] In some embodiments, the predefined spots can be selected for specific spectators, based on the spectator's preferences. If the spectator has a preference of viewing certain types of content, certain spots within the virtual-reality content can be selected for that spectator. Different spectators can therefore have different content selected from different spots and points of view into the virtual reality scene, as navigated by the HMD player. Furthermore, because multiple spectators can view the HMD player content, e.g. via a website that provides twitch-type sharing, the different spectators can have different viewing spots within the virtual-reality content. In alternate embodiments, all spectators can view the same content from the same viewing spots.

[0043] Furthermore, if spectators use a website that provides twitch-type sharing, many HMD player content feeds can be provided and be made selectable by the various spectators. The feeds can be shared via the internet, from a computer of the HMD player to a website, which then can publish the content and/or make it available for selection for view by spectators. By way of example, if the HMD player decides to share the HMD experience, that experience can be selected by a spectator. The spectator can then be provided with functionality for selecting the types of views, or be provided with specific pre-authored spots for viewing the virtual-reality content generated by the navigation of the HMD player. In one embodiment, providing a

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decoupled viewing spots into the virtual-reality content to spectators, avoids having to provide a hard fixed view that is typically provided from the perspective of the actual HMD player.

[0044] In some embodiments, the view provided to spectator can also be from the perspective of the actual HMD player, but can be provided with a slightly decoupled connection, referred to as a rubber band link or coupling. The rubber band link provides for a viewing spot that is similar to a virtual camera positioned above the head of the HMD player. The virtual camera that provides that view can move and follow the view of the HMD player, with a slight delay behind the movements of the HMD player. By way of example, if the HMD player looks to the left quickly, the virtual camera can shift slowly to the left following the HMD players viewing direction. If the HMD player moves his head up and down quickly, the delay of the virtual camera can avoid any movement either up or down, since the direction of the HMD player returns to straight ahead.

[0045] In still further embodiments, the spectator can be provided with different viewing spots into the virtual-reality environment, which may also include looking at the HMD player or the character being controlled by the HMD player. In one embodiment, this configuration can define a type of automatic cameraman angle, which is viewing the HMD player's character as it traverses the virtual environment. The angle provided to the spectator is therefore more interesting and can shift or pop between different viewing spots, as the HMD player traverses to different locations within the environment, the game, the content, or scenes.

[0046] In one embodiment, the methods, systems, image capture objects, sensors and associated interface objects (e.g., gloves, controllers, hands, etc.) are configured to process data that is configured to be rendered in substantial real time on

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a display screen. The display may be the display of a head mounted display (HMD), a display of a second screen, a display of a portable device, a computer display, a display panel, a display of one or more remotely connected users (e.g., whom may be viewing content or sharing in an interactive experience), or the like.

[0047] It will be obvious, however, to one skilled in the art, that the present disclosure may be practiced without some or all of these specific details. In other instances, well known process operations have not been described in detail in order not to unnecessarily obscure the present disclosure.

[0048] Figure 1 illustrates a system for interactive gameplay of a video game, in accordance with an embodiment of the disclosure. A user 100 is shown wearing a head-mounted display (HMD) 102. The HMD 102 is worn in a manner similar to glasses, goggles, or a helmet, and is configured to display a video game or other content to the user 100. The HMD 102 provides a very immersive experience to the user by virtue of its provision of display mechanisms in close proximity to the user's eyes. Thus, the HMD 102 can provide display regions to each of the user's eyes which occupy large portions or even the entirety of the field of view of the user.

[0049] In one embodiment, the HMD 102 can be connected to a computer 106. The connection to computer 106 can be wired or wireless. The computer 106 can be any general or special purpose computer known in the art, including but not limited to, a gaming console, personal computer, laptop, tablet computer, mobile device, cellular phone, tablet, thin client, set-top box, media streaming device, etc. In one embodiment, the computer 106 can be configured to execute a video game, and output the video and audio from the video game for rendering by the HMD 102.

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[0050] The user 100 may operate a glove interface object 104a to provide input for the video game. Additionally, a camera 108 can be configured to capture images of the interactive environment in which the user 100 is located. These captured images can be analyzed to determine the location and movements of the user 100, the HMD 102, and the glove interface object 104a. In one embodiment, the glove interface object 104a includes a light which can be tracked to determine its location and orientation.

[0051] As described below, the way the user interfaces with the virtual reality scene displayed in the HMD 102 can vary, and other interface devices in addition to glove interface objects 104a, can be used. For instance, single-handed controllers can also be used, as well as two-handed controllers. In some embodiments, the controllers can be tracked themselves by tracking lights associated with the controllers, or tracking of shapes, sensors, and inertial data associated with the controllers. Using these various types of controllers, or even simply hand gestures that are made and captured by one or more cameras, it is possible to interface, control, maneuver, interact with, and participate in the virtual reality environment presented on the HMD 102.

[0052] Additionally, the HMD 102 may include one or more lights which can be tracked to determine the location and orientation of the HMD 102. The camera 108 can include one or more microphones to capture sound from the interactive environment. Sound captured by a microphone array may be processed to identify the location of a sound source. Sound from an identified location can be selectively utilized or processed to the exclusion of other sounds not from the identified location. Furthermore, the camera 108 can be defined to include multiple image capture

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devices (e.g. stereoscopic pair of cameras), an IR camera, a depth camera, and combinations thereof.

[0053] In another embodiment, the computer 106 functions as a thin client in communication over a network with a cloud gaming provider 112. The cloud gaming provider 112 maintains and executes the video game being played by the user 102. The computer 106 transmits inputs from the HMD 102, the glove interface object 104a and the camera 108, to the cloud gaming provider, which processes the inputs to affect the game state of the executing video game. The output from the executing video game, such as video data, audio data, and haptic feedback data, is transmitted to the computer 106. The computer 106 may further process the data before transmission or may directly transmit the data to the relevant devices. For example, video and audio streams are provided to the HMD 102, whereas a vibration feedback command is provided to the glove interface object 104a.

[0054] In one embodiment, the HMD 102, glove interface object 104a, and camera 108, may themselves be networked devices that connect to the network 110 to communicate with the cloud gaming provider 112. For example, the computer 106 may be a local network device, such as a router, that does not otherwise perform video game processing, but which facilitates passage of network traffic. The connections to the network by the HMD 102, glove interface object 104a, and camera 108 may be wired or wireless.

[0055] Additionally, though embodiments in the present disclosure may be described with reference to a head-mounted display, it will be appreciated that in other embodiments, non-head mounted displays may be substituted, including without limitation, a television, projector, LCD display screen, portable device screen (e.g. tablet, smartphone, laptop, etc.) or any other type of display that can be configured to

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render video and/or provide for display of an interactive scene or virtual environment in accordance with the present embodiments.

[0056] Figure 2A illustrates a head-mounted display (HMD), in accordance with an embodiment of the disclosure. As shown, the HMD 102 includes a plurality of lights 200A-H. Each of these lights may be configured to have specific shapes, and can be configured to have the same or different colors. The lights 200A, 200B, 200C, and 200D are arranged on the front surface of the HMD 102. The lights 200E and 200F are arranged on a side surface of the HMD 102. And the lights 200G and 200H are arranged at corners of the HMD 102, so as to span the front surface and a side surface of the HMD 102. It will be appreciated that the lights can be identified in captured images of an interactive environment in which a user uses the HMD 102. Based on identification and tracking of the lights, the location and orientation of the HMD 102 in the interactive environment can be determined. It will further be appreciated that some of the lights may or may not be visible depending upon the particular orientation of the HMD 102 relative to an image capture device. Also, different portions of lights (e.g. lights 200G and 200H) may be exposed for image capture depending upon the orientation of the HMD 102 relative to the image capture device.

[0057] In one embodiment, the lights can be configured to indicate a current status of the HMD to others in the vicinity. For example, some or all of the lights may be configured to have a certain color arrangement, intensity arrangement, be configured to blink, have a certain on/off configuration, or other arrangement indicating a current status of the HMD 102. By way of example, the lights can be configured to display different configurations during active gameplay of a video game (generally gameplay occurring during an active timeline or within a scene of the

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game) versus other non-active gameplay aspects of a video game, such as navigating menu interfaces or configuring game settings (during which the game timeline or scene may be inactive or paused). The lights might also be configured to indicate relative intensity levels of gameplay. For example, the intensity of lights, or a rate of blinking, may increase when the intensity of gameplay increases. In this manner, a person external to the user may view the lights on the HMD 102 and understand that the user is actively engaged in intense gameplay, and may not wish to be disturbed at that moment.

[0058] The HMD 102 may additionally include one or more microphones. In the illustrated embodiment, the HMD 102 includes microphones 204A and 204B defined on the front surface of the HMD 102, and microphone 204C defined on a side surface of the HMD 102. By utilizing an array of microphones, sound from each of the microphones can be processed to determine the location of the sound's source. This information can be utilized in various ways, including exclusion of unwanted sound sources, association of a sound source with a visual identification, etc.

[0059] The HMD 102 may also include one or more image capture devices. In the illustrated embodiment, the HMD 102 is shown to include image capture devices 202A and 202B. By utilizing a stereoscopic pair of image capture devices, three-dimensional (3D) images and video of the environment can be captured from the perspective of the HMD 102. Such video can be presented to the user to provide the user with a "video see-through" ability while wearing the HMD 102. That is, though the user cannot see through the HMD 102 in a strict sense, the video captured by the image capture devices 202A and 202B (e.g., or one or more front facing cameras 108' disposed on the outside body of the HMD 102, as shown in fig. 3 below) can nonetheless provide a functional equivalent of being able to see the

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environment external to the HMD 102 as if looking through the HMD 102. Such video can be augmented with virtual elements to provide an augmented reality experience, or may be combined or blended with virtual elements in other ways. Though in the illustrated embodiment, two cameras are shown on the front surface of the HMD 102, it will be appreciated that there may be any number of externally facing cameras installed on the HMD 102, oriented in any direction. For example, in another embodiment, there may be cameras mounted on the sides of the HMD 102 to provide additional panoramic image capture of the environment.

[0060] Figure 2B illustrates one example of an HMD 102 user interfacing with a client system 106, and the client system 106 providing content to a second screen display, which is referred to as a second screen 107. As will be described below, the client system 106 may include integrated electronics for processing the sharing of content from the HMD 102 to the second screen 107. Other embodiments may include a separate device, module, connector, that will interface between the client system and each of the HMD 102 and the second screen 107. In this general example, user 100 is wearing HMD 102 and is playing a video game using controller 104. The interactive play by user 100 will produce video game content (VGC), which is displayed interactively to the HMD 102.

[0061] In one embodiment, the content being displayed in the HMD 102 is shared to the second screen 107. In one example, a person viewing the second screen 107 can view the content being played interactively in the HMD 102 by user 100. In another embodiment, another user (e.g. player 2) can interact with the client system 106 to produce second screen content (SSC). The second screen content produced by a player also interacting with the controller 104 (or any type of user interface, gesture,

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voice, or input), may be produced as SSC to the client system 106, which can be displayed on second screen 107 along with the VGC received from the HMD 102.

[0062] Accordingly, the interactivity by other users who may be co-located or remote from an HMD user can be social, interactive, and more immersive to both the HMD user and users that may be viewing the content played by the HMD user on a second screen 107. As illustrated, the client system 106 can be connected to the Internet 110. The Internet can also provide access to the client system 106 to content from various content sources 120. The content sources 120 can include any type of content that is accessible over the Internet.

[0063] Such content, without limitation, can include video content, movie content, streaming content, social media content, news content, friend content, advertisement content, etc. In one embodiment, the client system 106 can be used to simultaneously process content for an HMD user, such that the HMD is provided with multimedia content associated with the interactivity during gameplay. The client system 106 can then also provide other content, which may be unrelated to the video game content to the second screen. The client system 106 can, in one embodiment receive the second screen content from one of the content sources 120, or from a local user, or a remote user.

[0064] Figure 3 conceptually illustrates the function of the HMD 102 in conjunction with an executing video game, in accordance with an embodiment of the disclosure. The executing video game is defined by a game engine 320 which receives inputs to update a game state of the video game. The game state of the video game can be defined, at least in part, by values of various parameters of the video game which define various aspects of the current gameplay, such as the presence and

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location of objects, the conditions of a virtual environment, the triggering of events, user profiles, view perspectives, etc.

[0065] In the illustrated embodiment, the game engine receives, by way of example, controller input 314, audio input 316 and motion input 318. The controller input 314 may be defined from the operation of a gaming controller separate from the HMD 102, such as a handheld gaming controller (e.g. Sony DUALSHOCK®4 wireless controller, Sony PlayStation ®Move motion controller) or glove interface object 104a. By way of example, controller input 314 may include directional inputs, button presses, trigger activation, movements, gestures, or other kinds of inputs processed from the operation of a gaming controller. The audio input 316 can be processed from a microphone 302 of the HMD 102, or from a microphone included in the image capture device 108 or elsewhere in the local environment. The motion input 318 can be processed from a motion sensor 300 included in the HMD 102, or from image capture device 108 as it captures images of the HMD 102. The game engine 320 receives inputs which are processed according to the configuration of the game engine to update the game state of the video game. The game engine 320 outputs game state data to various rendering modules which process the game state data to define content which will be presented to the user.

[0066] In the illustrated embodiment, a video rendering module 322 is defined to render a video stream for presentation on the HMD 102. The video stream may be presented by a display/projector mechanism 310, and viewed through optics 308 by the eye 306 of the user. An audio rendering module 304 is configured to render an audio stream for listening by the user. In one embodiment, the audio stream is output through a speaker 304 associated with the HMD 102. It should be

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appreciated that speaker 304 may take the form of an open air speaker, headphones, or any other kind of speaker capable of presenting audio.

[0067] In one embodiment, a gaze tracking camera 312 is included in the HMD 102 to enable tracking of the gaze of the user. The gaze tracking camera captures images of the user's eyes, which are analyzed to determine the gaze direction of the user. In one embodiment, information about the gaze direction of the user can be utilized to affect the video rendering. For example, if a user's eyes are determined to be looking in a specific direction, then the video rendering for that direction can be prioritized or emphasized, such as by providing greater detail or faster updates in the region where the user is looking. It should be appreciated that the gaze direction of the user can be defined relative to the head mounted display, relative to a real environment in which the user is situated, and/or relative to a virtual environment that is being rendered on the head mounted display.

[0068] Broadly speaking, analysis of images captured by the gaze tracking camera 312, when considered alone, provides for a gaze direction of the user relative to the HMD 102. However, when considered in combination with the tracked location and orientation of the HMD 102, a real-world gaze direction of the user can be determined, as the location and orientation of the HMD 102 is synonymous with the location and orientation of the user's head. That is, the real-world gaze direction of the user can be determined from tracking the positional movements of the user's eyes and tracking the location and orientation of the HMD 102. When a view of a virtual environment is rendered on the HMD 102, the real-world gaze direction of the user can be applied to determine a virtual world gaze direction of the user in the virtual environment.

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[0069] Additionally, a tactile feedback module 326 is configured to provide signals to tactile feedback hardware included in either the HMD 102 or another device operated by the user, such as a controller 104. The tactile feedback may take the form of various kinds of tactile sensations, such as vibration feedback, temperature feedback, pressure feedback, etc.

[0070] At present, streaming services for sharing game replays are very popular. The DualShock®4 wireless controller includes a "share button" directly on the controller to enable such sharing. Implementations of the present disclosure improve sharing replays for people who wish to explore the replays using an HMD/VR headset. Implementations of the present disclosure provide for rendering of a game replay with a very wide field of view to allow the spectator to move his head freely using an HMD and view the replay from novel vantage points. The traditional streaming approach would limit the replay to only what the original player viewed, so that the view direction would be independent of the spectator's head position and orientation, and if the spectator using an HMD moved his head, nothing would change.

[0071] Implementations of the disclosure provide for the rendering of videos in a wide enough field of view to support novel viewpoints in an HMD. A custom build of a game engine that runs on a cloud server (e.g. on console gaming hardware, e.g. PlayStation®4 hardware, in the cloud), that accepts as input game state streamed from the original player's game engine and uses it to render an extremely wide field of view (e.g. 150 degree plus) view of the game, that can then be used for real-time streaming and/or pre-recorded playback of that game session. It will be appreciated that the extremely wide field of view is in excess of the HMD's field of

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view, allowing for the spectator wearing the HMD to look around in the replay. The actual game is configured to stream its state to the networked version of the engine.

[0072] As described above, there is a need to provide users the ability to spectate, e.g., watch the interactive activity being experienced by users wearing HMDs 102. For example, one HMD virtual reality player may be immersed in the activity presented in the HMD, while other persons may be co-located with the player. These other co-located players may find enjoyment in watching the interactivity experienced or virtual reality scene being viewed by the HMD player. As used herein, an HMD player is one that is viewing content presented on the HMD, or can be one that is interacting with some content resented on the HMD, or can be playing a game presented on the HMD. As such, reference to the player, is only made with reference to the user that is wearing the HMD, irrespective of the type of content being presented on the HMD.

[0073] In still other embodiments, other persons that are not co-located with the HMD player may wish to view the content, interactivity, or media being presented in the HMD of the HMD player. For instance, a website may be provided to present users with the ability to select from different HMD players, so as to watch and spectate while the HMD player performs his or her activities. This example is similar to standard Twitch-type experiences, which allow users connected to the Internet to access the website and search for different types of content or media being played by remote players. The remote players may, in some embodiments, be playing games using an HMD 102.

[0074] In other embodiments, the remote players may be playing games or watching content using a display screen of a device or a television display screen. Broadly speaking, users wishing to watch the activity of another player that is remote,

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e.g., over a website, can then select specific players or types of games, or thumbnails of the games, or thumbnails of the content, to view the activity being directed by the HMD player. Thus, a website can be provided that enables users to view and select specific interactive content that may be actively played by a remote HMD player. The remote viewer wishing to view the activity by the HMD player, can simply click on that content and begin watching.

[0075] The person watching and viewing the actions by the HMD player is generally referred to as a spectator. Spectators are those persons who are given access to view the activities, interactivities, actions, movements, etc., but are not necessarily controlling the game action. For this reason, these viewers are referred to as spectators. In the context of an HMD player, the content being presented in the HMD display is dynamic and is controlled by the movements of the HMD player. For example, when the HMD player moves his or her head around, that player is presented with different content that is viewable, similar to the way real world viewing of a person's surroundings can occur.

[0076] Although the head movements of the HMD player are natural to the HMD player, a spectator that is provided the same view as the HMD player may become nauseous or dizzy when viewing the content due to the rapid movements. The reason for this is that the viewer is not him or herself moving their head in a similar way as does the HMD player, which causes the content to be changed based on the direction of viewing by the HMD player. In the various embodiments described herein, methods, systems, computer readable media, and cloud configurations are provided, which enable spectators to view content being viewed by the HMD player, in a way that does not distract the spectator nor does it have the tendency of causing the spectator to become dizzy or nauseous.

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[0077] By way of example, some of the embodiments described herein teach ways of providing different viewing spots within the virtual reality environment being viewed by the HMD player. In some embodiments, the viewing spots are fixed in terms of the angle, direction, and content being viewable by the spectator. Thus, if the HMD player moves his or her head one way or the other, the spectator's view into the virtual reality environment may be maintained stable. In some embodiments, as the HMD player moves and traverses through different virtual reality environments scenes, locations, areas, levels, chapters, etc., the spectating user can be provided with different viewing spots, which are customized to the viewing spectator. For instance, various viewing spots can be pre-authored for different types of content.

[0078] If the content is a video game, viewing spots along different paths that can be taken in the videogame can be predefined as pre-authored spots for viewing by the spectator. Thus, when the HMD player moves along a particular path, the spectator can be provided with viewing spots along that path, which may be preselected or pre-authored by the game developer, earlier spectators, or the HMD player. In this manner, a spectator may be popped from one viewing spot to the next viewing spot, based on a determination that those viewing spots are superior or better or provide more interesting views as the HMD player moves about an HMD VR environment. In further embodiments, spectators may be provided with sub- portions of viewable content that is being viewed by the HMD player. In other embodiments, spectators may be provided with additional content that is not yet viewable by the HMD player.

[0079] Depending on the game, the environment, the type of content, the type of multimedia, or by defined rules or constraints, spectators may be provided with less or more of the viewable content being viewed by the HMD player. As

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mentioned above, the content that is made viewable to a spectator can be the same content being viewed by the HMD player, but from a reference point of view that is different than the HMD player. However, in some embodiments the view provided to the spectator can be similar to the HMD player's view, but at a slight different angle, or viewing perspective. Further, the spectator can be provided a similar view to that provided to the HMD player, from the context of a virtual camera writing over the head of the HMD virtual player. In one embodiment, instead of moving the virtual camera view provided for the spectator of the content being viewed by the HMD player, the spectator's view is not moved at the same rate or speed as the view is moved by the HMD player when the HMD player makes head movements.

[0080] In this embodiment, the virtual camera view provided to the spectator can be moved at a slower rate than does the view of the HMD player, which changes based on the actual speed of the user's head movements. Still further, the movement of the virtual camera view can be set to follow the movement of the HMD player's head, with a delay. The delay can be similar to a conceptual rubber band that links the virtual camera view to the movements of the HMD. That is, if the user's head moves to the left quickly, the spectator's virtual camera view will move to the left slower, with the delay similar to the way an object would trail when connected by a rubber band to a moving object ahead of it. In some configurations, a gearing ratio would be applied to the movement of the virtual camera view, such that the virtual camera moves at a rate that trails the movement of the actual view of the HMD player. The gearing ratio may be modified dynamically by the computer, the game, and/or program executing the views for the spectator into the virtual reality scenes. The gearing may be modified, for instance, faster in some games, some scenes, some situations, some levels, for some users, etc., or slower in other instances. By using

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dynamic gearing, the movement of the virtual camera view can be smoothed out, so as to provide a more pleasant viewing experience for the spectator view, even when the HMD moves fast or erratic.

[0081] In further embodiments described below, spectators can be provided with visual clues to enable the spectator to identify where the HMD player is looking within a virtual reality environment. One configuration can allow for tracking of the gaze of the HMD player, to determine what exactly the HMD player is looking at within the VR scene. For the spectator, who may be viewing the VR scene from the perspective of the virtual camera view (e.g. virtual camera floating behind the head of the HMD player), it would be useful to determine what is the focus in the particular scene. In this manner, the spectator can also focus upon what the virtual reality player feels is important in the scene.

[0082] In some examples, and a first-person shooter game, the spectator may want to know where the HMD player is looking, such as to identify enemies or obstacles. In one embodiment, by tracking the gaze of the HMD player, it is possible to identify what the HMD player is looking at, by highlighting content, changing the contrast of certain objects or locations, encircle content, add a marker, grey-out in area, add flashing beacons, add text, add floating objects, etc. In this manner, the spectator can then know for sure where the HMD player is looking, so the spectator himself can also view that same area and experience the content with more enjoyment.

[0083] For instance, the HMD player may be more experienced in a particular game, or has watched a particular type of content, and providing this indicator of where the HMD player is looking in the virtual reality scene will provide guidance, visual cues, and help to the spectator. In some embodiments, these

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identifying features can be turned on and off, so as to remove distraction. The identifiers can be activated by the HMD player or can be activated by the spectator. In some embodiments, where multiple spectators are viewing the same content provided by the HMD player, e.g. in a Twitch presentation, each of the spectators can be provided with different controls that provide to them the ability to provide the visual indicators or not. From the perspective of the HMD player, the indicators may not be shown at all in the HMD of the HMD player. However, these indicators will be useful to the spectator or spectators that may be viewing the content being interacted with by the HMD player.

[0084] In some embodiments, spectators can be provided with controls that allow the spectator to identify specific listening zones within the virtual reality environment. The listening zones allow spectators to select where in the virtual reality environment they wish to listen from. What this means is that the spectator is essentially provided with listening audio and acoustics that mimic a situation where the spectator would actually be present in the scene from that specific location. By way of example, if a spectator is viewing HMD content that includes a building across the street, relative to the viewing location, the spectator can identify some location in the building, e.g. the second-story where a person is standing, and select to listen at that location.

[0085] This functionality provides a listening teleportation for the spectator, which allows the spectator to listen to the content of audio, and acoustics as if the spectator were sitting or standing in the second-story building. The audio and acoustics, in one example, would essentially magnify the audio sounds that would be present at the second-story location of the building, and reduce the sounds that are further away from that virtual location. In some embodiments, the spectator can from

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time to time, select different locations within the environment for being the primary listening zone. In still other embodiments, the listening zone can also be adjusted to be the same listening zone of the HMD player. A spectator can be provided with switchable selection capabilities, so as to identify where in the virtual environment the spectator wishes to listen.

[0086] Again, it is noted that the spectator can be local to the HMD player, and can be viewing the HMD content on a second screen as described with reference to figure 2B. Alternatively, the local viewer, being a spectator, can also be wearing an HMD, which provides spectator viewing into the HMD player content. In still another embodiment, the spectator can be remote, and can be viewing from a webpage if the HMD player content is being published to a website that allows for viewing. In some embodiments, the remote viewers, which act as spectators, can be watching live or substantially live content by the HMD player. In other embodiments, the remote viewers, which act as spectators, can be watching a recorded version of the content that was viewed by the HMD player. Still further, websites can be provided that allow for multiple or even many multiples of spectators to watch the same content of the HMD player, whether live or recorded.

[0087] Figure 4 illustrates an example of an HMD VR player 100, who may be interacting with a virtual environment 450 via computing device 106, in accordance with one embodiment. The HMD VR player 100 is therefore driving the interactivity within the VR environment 450, which will move the scenes presented in the HMD 102, as well as the replicated view shown in the display 107. The spectator can therefore be one that is viewing the display 107, such as spectator 140. As mentioned above, the spectator 140 is a social screen spectator, as that spectator is able to interact with the HMD player 100 in a co-located space. In other

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embodiments, or in addition to the co-located spectator 140, an HMD spectator 150 can also be provided access to the content being navigated by the HMD player 100. The HMD spectator 150 can be co-located with the HMD player 100. In other embodiments, the HMD spectator 150 can be remotely located from the HMD player and can view the content from a website, such as a twitch-type viewing website. Therefore, the example shown in figure 4 is only one example, and it is possible to have multiple spectators or even thousands of spectators viewing the HMD players content from remote locations. The spectators, whether they be viewing a display 107 or viewing the content via an HMD, will be provided with functionality for improving the spectating experience.

[0088] Figure 5 illustrates an example of the HMD player 100 that is moving about the virtual reality environment 450, and viewing different content as he moves throughout the scene. As shown, the HMD player 100 has moved forward in the scene, which has exposed new content, such as an extension of the road, a building 502, a golfer 504, a lake 506, a dog 508, and other multimedia content. These types of multimedia content presented in the VR environment 450 are simply examples, and the type of content will change depending on the type of content being viewed, interacted with, or displayed. In one example, the VR environment 450 can be associated with pre-authored viewing spots, such as spot 1, spot 2, spot 3, and spot 4. Each of those spots have a particular viewing direction and angle into the VR environment 450.

[0089] Spot 1 is provided with a virtual camera view, which may float behind the head of the HMD player 100, which provides a close replica of the view being produced by movements of the HMD 102 of the HMD player 100. The other spots may be decoupled from the viewing angle of the HMD player 100, and instead

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can be placed throughout the VR environment 450, based on pre-authoring by content creators, or other users that may know where interesting content may reside within the virtual environment. For instance, if the content creator is a game developer, the game developer will know where interesting spots may be within the different VR environment locations, so that spectators can be provided with better viewing of action, things, movements, interactivity, or scenes, as the HMD player traverses the virtual reality environment 450 during one or more game sessions or viewing sessions.

[0090] In this particular example, the spectator is an HMD spectator 150. The HMD spectator 150 can be provided with specific viewing spots at different times within the activity shown of the virtual reality environment 450. For instance, as the HMD player 100 traverses or moves about the virtual reality environment 450, different content is shown, and based on the content that is being shown, different spots are selected for viewing consumption by the spectator or spectators. By way of example, the HMD spectator 150 is provided with a sequence of spots, such as spot 1 at time t=0, spot 3 at time t=1, spot 2 at time t=2, and so on.

[0091] Therefore, depending on where the HMD player 100 traverses, different spots may be selected dynamically for the spectator, so as to provide the most interesting views of content. By way of example, if the HMD player has reached the location of the golf course, the golfer 504 will be the focus of the viewing spot 4. If the HMD player has reached the location of the building 502, the viewing spot 2 will be provided to the spectator to allow viewing of the building 502 and the dog 508, which may be predetermined to be an interesting location or vantage point or viewpoint within the virtual reality environment 450.

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[0092] Figure 6 illustrates an example of the HMD player 100 moving about a view path 605, which provides different views into the virtual reality environment 450. Thus, as the HMD VR player 100 moves about the virtual reality environment 450, different content can be shown in the HMD 102, when viewed by the HMD player 100. For simplicity, a plurality of objects O1 – O14 are shown located throughout the virtual reality environment 450, and depending on the virtual reality player view 602, different ones of the objects will be visible to the HMD player 100. By way of example, the objects (O), are represented by icons X, O, Δ, □, but these icons can represent any type of content that can be presented on a display screen, such as characters, textures, terrain, interactive content, weapons, vehicles, buildings, graphics, text, and generally any type of multimedia viewable content.

[0093] In this example, it is shown that certain ones of the objects are viewable by the spectator 150, depending on the viewing spot that is provided for the spectator. In one embodiment, the viewing spots are pre-authored, so as to define where in the virtual reality environment 450 the spectator will be allowed to view, depending on where the VR player view 602 is focused. In some embodiments, these pre-authored spots are those that are believed to be interesting, novel, or provide better perspective into the virtual reality environment 450. In one embodiment, the viewing spots can be preselected, as pre-authored spots. As mentioned above, the pre-authored spots are those that are believed to provide interesting viewing angles or perspectives.

[0094] In this example, the selected spots for user 1, which is the spectator 150, will be spot 3, spot 6, and then spot 9. Spot 3 provides a somewhat overhead view that captures certain ones of the objects in the VR player view 602. Spot 6 provides a direct viewing angle in front of the HMD player 100, that highlights or

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