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Determining Optimal Player Position, Distance, and Scale from a Point of Interest on a Terrain

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Abstract:

In a three-dimensional virtual world that is presented as part of a virtual reality environment, a player is teleported from one location displaying a point of interest to a new location displaying a new point of interest. When positioning the player at the location within the three-dimensional virtual world displaying the new point of interest, a virtual reality application determines a player viewing position at the location in order for the player to view the point of interest in a consistent and optimized fashion. The determination made by the virtual reality application, comprehending factors of scale, altitude, and direction, provides the player with a view that is comfortable and makes the point of interest easily recognizable.

Keywords:

Virtual reality, point of interest, user position, horizon angle, view, gaze

Background:

Virtual reality (VR) environments rely on display, tracking, and VR-content systems. Through these systems, realistic images, sounds, and sometimes other sensations simulate a user's physical presence in an artificial environment. Each of these three systems are illustrated below in Fig. 1.

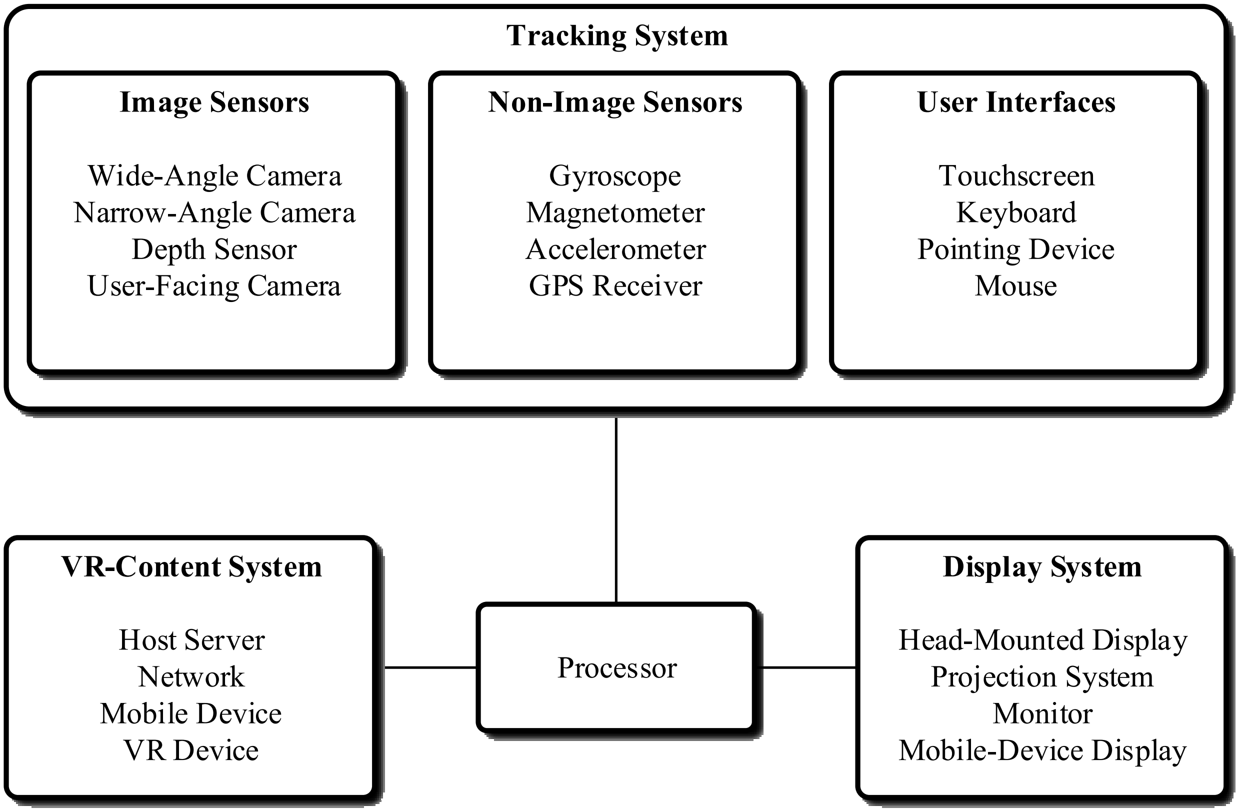

Fig. 1

The systems described in Fig. 1 may be implemented in one or more of various computing devices that can support VR applications, such as servers, desktop computers, VR goggles, computing spectacles, laptops, or mobile devices. These devices include a processor that can manage, control, and coordinate operations of the display, tracking, and VR-content systems. The devices also include memory and interfaces. These interfaces connect the memory with the systems using various buses and other connection methods as appropriate.

The display system enables a user to "look around" within the virtual world. The display system can include a head-mounted display, a projection system within a virtual-reality room, a monitor, or a mobile device's display, either held by a user or placed in a head-mounted device.

The VR-content system provides content that defines the VR environment, such as images and sounds. The VR-content system provides the content using a host server, a network-based device, a mobile device, or a dedicated virtual reality device, to name a few.

The tracking system enables the user to interact with and navigate through the VR environment, using sensors and user interfaces. The sensors may include image sensors such as a wide-angle camera, a narrow-angle camera, a user-facing camera, and a depth sensor. Non-image sensors may also be used, including gyroscopes, magnetometers, accelerometers, GPS sensors, retina/pupil detectors, pressure sensors, biometric sensors, temperature sensors, humidity sensors, optical or radio-frequency sensors that track the user's location or movement (*e.g.*, user's fingers, arms, or body), and ambient light sensors. The sensors can be used to create and maintain virtual environments, integrate "real world" features into the virtual environment, properly orient virtual objects (including those that represent real objects, such as a mouse or pointing device) in the virtual environment, and account for the user's body position and motion.

The user interfaces may be integrated with or connected to the computing device and enable the user to interact with the VR environment. The user interfaces may include a touchscreen, a keyboard, a pointing device, a mouse or trackball device, a joystick or other game controller, a camera, a microphone, or an audio device with user controls. The user interfaces allow a user to interact with the virtual environment by performing an action, which causes a corresponding action in the VR environment (*e.g.,* raising an arm, walking, or speaking).

The tracking system may also include output devices that provide visual, audio, or tactile feedback to the user (*e.g.*, vibration motors or coils, piezoelectric devices, electrostatic devices, LEDs, strobes, and speakers). For example, output devices may provide feedback in the form of blinking and/or flashing lights or strobes, audible alarms or other sounds, songs or other audio files, increased or decreased resistance of a control on a user interface device, or vibration of a physical component, such as a head-mounted display, a pointing device, or another user interface device.

Fig. 1 illustrates the display, tracking, and VR-content systems as disparate entities in part to show the communications between them, though they may be integrated, *e.g.*, a smartphone mounted in VR goggles, or operate separately in communication with other systems. These communications can be internal, wireless, or wired. Through these illustrated systems, a user can be immersed in a VR environment. While these illustrated systems are described in the VR context, they can be used, in whole or in part, to augment the physical world. This augmentation, called “augmented reality” or AR, includes audio, video, or images that overlay or are presented in combination with the real world or images of the real world. Examples include visual or audio overlays to computing spectacles (*e.g.,* some real world-VR world video games or information overlays to a real-time image on a mobile device) or an automobile’s windshield (*e.g.,* a heads-up display) to name just a few possibilities.

In a particular embodiment of Fig. 1, virtual reality systems can create a virtual reality environment that provides a convenient method for a player to view one or more points of interest at different locations. For example, a VR-content system playing a three-dimensional geobrowser application can present a player a view of Times Square in New York and then teleport the player to Paris in order for the player to view the Eiffel Tower. When teleporting the player to any new location with a new point of interest to be viewed, it is important for the three-dimensional geobrowser application to take into account factors such as scale, altitude, or viewing direction. It would not, for example, be desirable to transport the player to Paris and then scale and position the player at an altitude such that the player is viewing only the bottom third of the Eiffel Tower. In similar fashion, it not would it be desirable to teleport the player back to New York, and scale and position the player such that the player is viewing Times Square in a direction originating from a curb in a back alley of midtown Manhattan. Methods for a virtual reality application, such as the three-dimensional geobrowser application, to determine scale, altitude, and directional information defining a player viewing position within a three-dimensional virtual world today are often manual and arbitrary. Such methods often result in a player viewing the point of interest at a scale or from an altitude or viewing direction that renders the point of interest unrecognizable to the player. A method of consistently determining, for a location with a point of interest within a three-dimensional virtual world, a player viewing position from which to view a point of interest that takes into account factors such as scale, altitude, and viewing direction is desirable.

Description:

In a real world scenario, it has been ergonomically determined that a person can comfortably view an object provided that (a) the viewing angle at which the object is viewed is approximately 15^0 below the horizon, (b) the object does not exceed 1 meter in height, and (c) the object is at 2 meters from the person. By applying these parameters in a normalized and consistent fashion to a three-dimensional virtual world, a virtual reality application can position a player at a location such that the view of the point of interest is not only comfortable, but also optimized to suit the player's needs in terms of recognizing the point of interest.

Fig. 2 depicts an example method for establishing the optimal distance and height for viewing a point of interest within a three-dimensional virtual world, normalized to the aforementioned parameters.

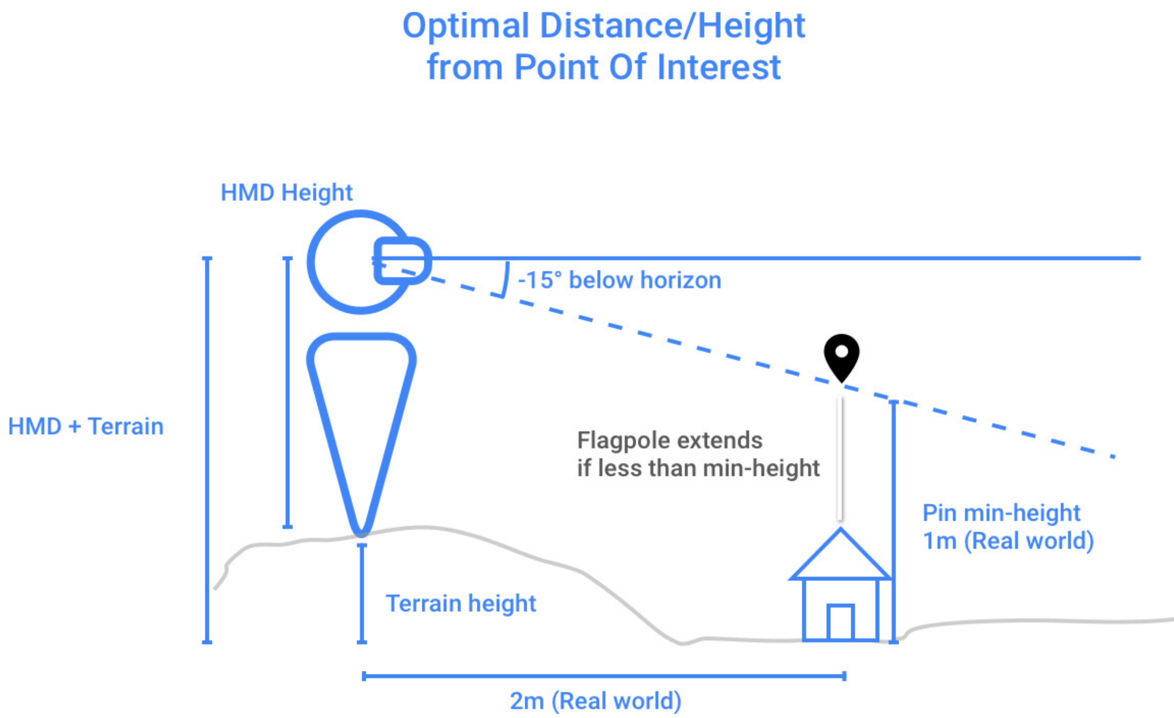

Fig. 2

Using available data, such as the geographic location and actual height of the point of interest, the virtual reality application determines a position, within the virtual world, for a display system that provides a viewing gateway (such as a Head-Mounted Display (HMD)). Applying the aforementioned ergonomic parameters, the position of the HMD at the location within the virtual world is determined. The virtual reality application also compensates for any underlying terrain associated with positioning of the viewing mechanism within the three-dimensional virtual world such that the viewing elevation experienced by the viewing mechanism, relative to any point or interest, remains consistent. The virtual reality application scales the player such that feet of the player are "planted" on the underlying terrain of the virtual world while the player is viewing the point of interest at a viewing angle that is consistent with respect to the horizon. If it is not possible to establish a useable minimum height for a point of interest, the virtual reality application may extend a "flagpole" from the point of interest, normalizing elevation of an icon or pin on the flagpole to 1 real-world meter. Scenarios where a flagpole may be required include, for example, a park, a field, or any other point of interest where a real world height of 1 meter is not exceeded.

Fig. 3 depicts one example method of a virtual reality application establishing the longitudinal or latitudinal player viewing position at a location near the point of interest in a three-dimensional virtual world. In the example of the virtual reality application identifies roads or pathways that are proximate to the point of interest in the real world. A determination is made by the virtual reality application that one or more longitudinal and latitudinal positions along a particular road or path that runs perpendicular to the point of interest would enable the player to easily recognize the point of interest. The virtual reality application then places the player in the three-dimensional virtual world at the determined longitudinal and latitudinal position and scales the player height in order to establish the player viewing position. If multiple longitudinal and latitudinal positions are available, the virtual reality application prioritizes the longitudinal and latitudinal position with the lowest elevation when making the determination of the player viewing position in order to maximize player scale.

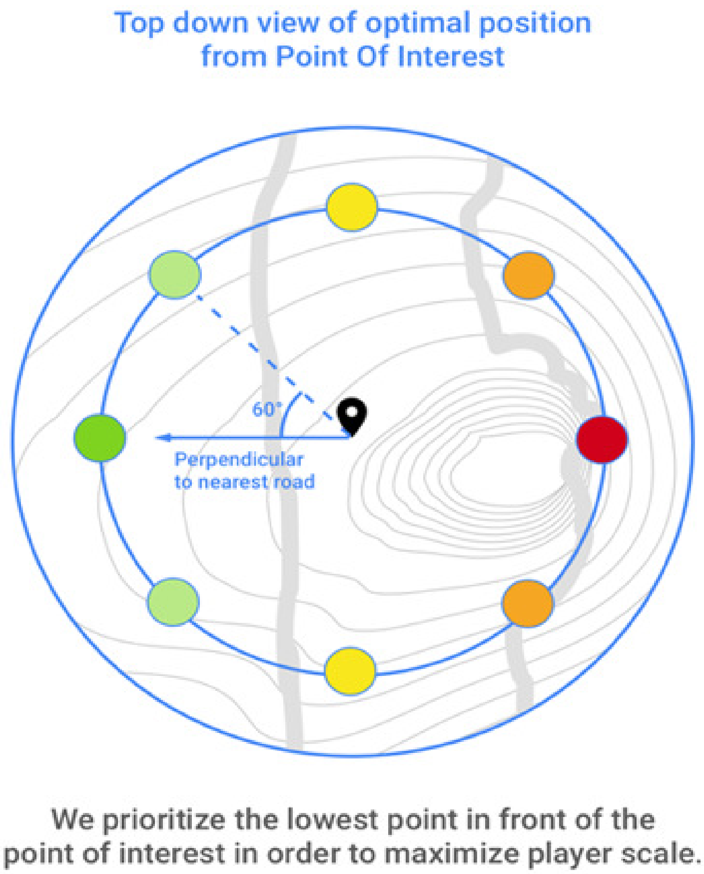

Fig. 3

The virtual reality application may use other data sets to establish longitudinal and latitudinal positions near the location of the point of interest that make the point of interest easily recognizable to the player. For instance, the virtual reality application may mine geotag information, assigned to videos or photographs of a particular point of interest by a general population of persons, in order to determine the most popular longitudinal and latitudinal position for viewing the point of interest. As another example, the virtual reality application may have access to a database that indicates lookouts or viewpoints associated with a point of interest, such as a map identifying viewpoints along the South Rim of the Grand Canyon.

Note that the virtual reality application is capable of determining a player viewing position based not only on the aforementioned parameters specific to optimal viewing conditions, but also on available ranges of parameters tailorable to the player's desires. For example, although a viewing angle of approximately 15° below the horizon has been described as optimal, a player may wish to view a point of interest from a player viewing position that is level with the top of the point of interest, in which case the viewing angle would be 0° with respect to horizon. Alternatively, the player may wish to have more of a "birds-eye view" of the point of interest, in which case the point of interest is positioned 30° below the horizon. For another example, the player may wish to view the object from a distance normalized to a real world distance as near 1.5 meters or normalized to a real world distance as far as 4 meters. A minimum height requirement for the player in the virtual world, such as 100, 150, and 200 meters may also be established to maintain a broad perspective of the point of interest in relation to others at or near the location.

All of the aforementioned parameters that impact the determined player viewing position can be established through automated optimization by the virtual reality application or through selection by the player. If the player desires a configuration based on selection, the player makes selections using any type of controller associated to the virtual reality application, including a headset-based controller detecting a gaze direction of the person wearing the headset, a mouse or joystick-based controller, a keypad-based controller, and so forth. Additionally, a voice recognition system may be used by the player to make selections.