Redirected Walking for Cord Management

Josh Weaver

Follow this and additional works at: http://www.tdcommons.org/dpubs_series

Recommended Citation
Weaver, Josh, "Redirected Walking for Cord Management", Technical Disclosure Commons, (December 18, 2017)
http://www.tdcommons.org/dpubs_series/1017
Redirected Walking for Cord Management

Abstract:

A player immersed in a virtual reality environment often interacts with a virtual reality scene while he is physically located in a virtual reality room. The player typically views the scene through a head-mounted display, which is connected to a host device or a network port via a communicative cord. When interacting with the virtual reality scene, the player may physically change and rotate his position in the virtual reality room in response to what is being displayed as part of the virtual reality scene. As a result, the communicative cord can wrap around and become entangled with itself or the player, resulting in discomfort or other undesirable conditions. A virtual reality tracking system monitors the player’s position within the virtual reality room and causes a virtual reality application to alter the virtual reality scene, resulting in the player changing and rotating his position in a manner that would prevent or manage cord mishaps is described.

Keywords:

Virtual reality, head-mounted display cord, virtual reality room, virtual reality player position, position-tracking system, head-mounted display

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.
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. Other sensors, such as bend or flex sensors, may be integrated into the cord to help build a model of a cord state and assist with cord tracking.

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.

A particular configuration of the systems of Fig. 1 presents a VR environment to a player in a physical space known as a virtual reality room. Within the virtual reality room, it is common for the player to don a head-mounted display that is used to display virtual reality scenes. It is also
typical for the head-mounted display to be physically coupled to a host device or to a network port within the virtual reality room via a communicative cord in order to overcome latency or performance issues that might manifest with a wireless connection.

A player’s range of motion for responding to a presented scene can have up to six degrees of freedom. For instance, while in the virtual reality room, the player may step towards a dog that is playing in a grass field (e.g., the player may translate along a plane representing two degrees of freedom, where the plane is defined by a first axis and a second axis). As another example, the player may jump vertically to initiate a parachute jump (a third degree of freedom defined by a third axis). The player may additionally rotate his body or head about any of the three axis in an effort to get a better view (the rotational positioning about each respective axis being the fourth, fifth, and sixth degrees of freedom). Fig. 2 below illustrates the six degrees of freedom:

![Fig. 2](image)

With these six degrees of freedom available to the player, a series of movements in response to the virtual reality scene can ultimately result in the player’s body or head rotating such that the cord wraps around and becomes entangled with itself or his body.
Description:

To alleviate these challenges, techniques are described that utilize a virtual reality application being presented by a VR-content system in conjunction with a head-mounted display and tracking system to monitor a player’s position in a virtual reality room. Based on the player’s position, the virtual reality application alters virtual reality scenes being presented with the intent of preventing or managing cord mishaps.

An illustration of a player in a virtual reality room is presented in Fig. 3 below:

![Fig. 3](http://www.tdcommons.org/dpubs_series/1017)

The virtual reality room illustrated in Fig. 3 may be of almost any dimension, providing space for the player to move and interact with virtual reality scenes presented by the virtual reality
application. In the virtual reality room, the player dons a head-mounted display (a type of display system of Fig. 1) that is communicatively coupled via a cord either to a host device (e.g., VR-content system) in the virtual reality room or to a network port. From the host device or the network port, and through the cord, the head-mounted display receives signals necessary to render the virtual reality scene generated by the virtual reality application. The virtual reality application utilizes information provided by a head-mounted display and tracking system (not illustrated). The head-mounted display and tracking system can be, for example, a laser-based system. The laser-based system may have a multitude of fixed lasers or a raster laser that interacts with diodes incorporated into the head-mounted display in order to track the head-mounted display’s movement with respect to any of the six degrees of freedom available to the player. Another example head-mounted display and tracking system is a camera-based system where cameras are stationed within the virtual reality room. The cameras may be trained on the head-mounted display to track lateral movement and rotation of the head-mounted display as the player interacts with the virtual reality scene and moves about the virtual reality room. Instrumentation, such as accelerometers or infrared emitters, may also be incorporated into the head-mounted display to provide positional information that either complements functionality of the aforementioned systems or is provided in the absence of the systems.

As a virtual reality application initializes, the virtual reality application establishes origin parameters. Establishing the origin parameters includes not only establishing the position of the head-mounted display within the virtual reality room, but also establishing a cord state (e.g., the cord is in an unwrapped condition and originates from a specific position in the virtual reality room corresponding to the host device or network port). Establishing origin parameters may also include
identifying the positions of any obstacles, such as the host device furniture in the virtual reality room, which the player needs to navigate about while interacting with the virtual reality scene.

Once the virtual reality application has initialized, the virtual reality application utilizes information provided by the head-mounted display and tracking system to monitor the player’s position in relationship to the virtual reality room as well as the state of the cord. If, through the course of the player’s interactions with a series of virtual reality scenes, the virtual reality application determines that the cord has become wrapped about the player, the virtual reality application is configured to alter a current or upcoming virtual reality scene in order to redirect the player’s movement and unwrap the cord.

Consider the example where the player is interacting with the virtual reality scene with the dog playing in the grass field. The virtual reality application has determined, using information provided by the head-mounted display and tracking system, that the player has circled about the virtual reality room in a counter-clockwise fashion in an effort to catch the dog, and as a result, that the cord has become wrapped about the player. In an effort to unwrap the cord, the virtual reality application positions the dog such that the player’s next motions to catch the dog requires the player to move in a manner that has the effect of a clockwise rotational movement and will unwrap the cord. The player’s movement could include a purely rotational movement of his head in a clockwise fashion in order to view the dog or a series of translational movements to catch the dog that result in a clockwise rotation of his body (e.g., the player walks in a circle).

Fig. 4 below illustrates the aforementioned example. The dog playing in the grass field has resulted in virtual reality scene A, where the player is looking and moving to the left in order to catch the dog. The virtual reality application has received information from the head-mounted display and tracking system and determined that the cord is wrapped about the player. In response
to this determination, the virtual reality application alters the scene and repositions the dog in order to unwrap the cord. If the virtual reality repositions the dog as illustrated by virtual reality scene B, the player is redirected and rotates his view clockwise and moves to his right in order to view and catch the dog. The virtual reality application continues altering the virtual reality scene in this manner in order to continually redirect the player and eventually unwrap the cord.

![Diagram of virtual reality scene](image)

**Fig. 4**

Although the virtual reality application may developed to work with a custom tracking system for the head-mounted display, the virtual reality application may also be developed using an application program interface (API) provided by manufacturers of commercially available head-mounted displays and head-mounted tracking systems.

In addition to or as an alternative to cord management purposes, the virtual reality application used in conjunction with the head-mounted display and tracking system to alter virtual
reality scenes can apply to helping the player navigate around obstacles in the virtual reality room. Such obstacles can include static obstacles, such as the virtual reality host system, a couch, a wall, and even non-static obstacles, such as pets, children, or other VR users. Altering the virtual reality scene may entail having objects of interest within the virtual reality scene (such as the dog) being positioned to have the player redirected as previously described. As another example, the objects in the virtual reality room may be projected by the virtual reality application into the virtual reality scene as an object to avoid (for example, a couch in the virtual reality room may be projected into the virtual reality scene as a boulder or a mud- puddle). Altering virtual reality scenes in order to navigate about obstacles in the virtual reality room is applicable not only to the head-mounted display tethered to the host system or the network port with the cord, but also to a head-mounted display that is wireless, integrated (e.g., mobile phone in VR goggles), or that is integrated with a backpack system being worn by the player.