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Volumetric Framework for Third-Party Content Placement in Virtual 3D Environments

BACKGROUND

Various computing systems have been developed that render virtual, three-dimensional (3D) environments for presentation to users. By way of example, virtual reality (VR) systems may render 3D environments for presentation to a user through a head-mounted display. The head-mounted display may include an electronic display screen and optical lenses through which the user views the screen and the displayed 3D environment. The system renders the 3D environment stereoscopically on the screen, which creates the illusion of depth to a user when viewed through the lenses of the head-mounted display. Some VR systems provide an immersive user experience so the user feels as if he or she is actually present in the virtual environment. Some VR systems allow a user to look around a 3D environment, move about the 3D environment, and manipulate virtual objects within the 3D environment.

User systems may obtain virtual 3D environments from developers that make the environments available for public or private distribution.

SUMMARY

This document describes a content distribution system that implements a framework for placing 3D objects specified by third-party content providers in virtual 3D environments. The framework defines a set of possible 3D models on which third-party content items can be presented as 3D objects. Developers of the 3D environments, third-party content providers, or a content selection service of the distribution system may select 3D objects that show third-party content to place in the 3D environments.

In some implementations, 3D objects have different sizes and volumes. Because the volume of a 3D object corresponds to the amount of space it will occupy in a 3D environment, the distribution system or the developer may charge a third-party content provider for placement of a 3D object showing third-party content in the 3D environment based at least in part on the volume of the 3D object.

DESCRIPTION OF DRAWINGS

Figure 1 is a diagram of an example computing network that facilitates placement of third-party content objects in 3D environments.

Figure 2 is a view of a cube-shaped virtual object showing third-party content within a virtual 3D environment.

Figure 3 is a view of virtual objects within a virtual 3D environment, where the environment includes a virtual space designated for the display of third-party content.

DETAILED DESCRIPTION

Developers or publishers of virtual, 3D environments may desire to incorporate in their environments content for presentation to users from a range of sources. As with 2D environments, such as web pages, spreadsheets, slide presentations, or other electronic documents, 3D environments may be populated with both first-party content and third-party content. First-party content generally refers to content that is closely tied to the developer of the 3D environment, such as graphics, text, images, and 3D models that the developer has specifically defined or created for the 3D environment. In contrast, third-party content may or may not relate to the subject matter of the 3D environment and is provided by a third-party

content provider. Third-party content may be placed in various types of 3D environments, including virtual-reality environments, augmented-reality environments, and mixed-reality environments. The 3D environments may be rendered and displayed to a user using a suitable display device, such as a head-mounted display (HMD), a television, a desktop monitor, or a display on a mobile device such as a smartphone or tablet computer.

A 3D environment may define a virtual world for a user. The virtual world can include, for example, a virtual terrain (e.g., a ground plane) and virtual 3D objects that resemble real-world or fictional objects. A user may explore the 3D environment using controls to look around the environment, move about the environment, and interact with virtual 3D objects in the environment. Structures within the 3D environment, such as terrain and virtual 3D objects, may be rendered using a 3D model that defines a geometry for the structure and a texture shown at the surface on the 3D model.

Some 3D objects within an environment show third-party content. For example, an object may be textured with one or more images from one or more third-party content providers. In some instances, the images textured on virtual 3D objects are advertisements for a business, product, or service of the third-party content provider. Videos, animations, text, and other forms of media may also be displayed on a virtual 3D object.

In order to incorporate third-party content into a 3D environment, developers may partner with a third-party content distribution service that provides a clearinghouse for developers to access third-party content which third-party content providers have submitted and made available for distribution. The distribution service may be implemented by a network-based content distribution system having one or more computers in one or more locations. The distribution service may potentially make third-party content from many (e.g., tens, hundreds,

thousands, or millions) third-party content providers available for distribution. For example, third-party content providers may create distribution campaigns for third-party content using the distribution service and developers may indicate criteria for eligible third-party content items to be presented in their respective 3D environments. The distribution service may then make automated selections of third-party content to present in 3D environments. Alternatively, the developer of a 3D environment may manually select third-party content that has been made available on the distribution service for placement in the 3D environment.

Figure 1, below, is a diagram of an example networked computing system 100 that facilitates placement of third-party content objects in 3D environments. User devices 106, such as virtual reality or augmented reality computing devices, may obtain 3D environments from the servers 104 of the developers of the 3D environments, or from the servers of other publishers of the 3D environments such as online marketplaces. When a 3D environment is executed at a user device 106, an application running the 3D environment may call on the third-party content distribution system 110 to obtain third-party content for a virtual object in the 3D environment. In some instances, the third-party content is submitted from or originates from the servers 108 of a third-party content provider.

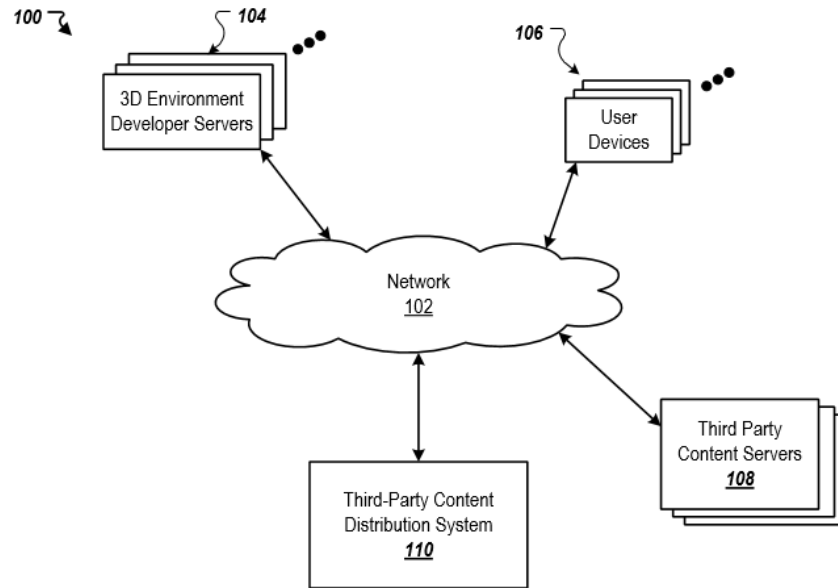


FIG. 1

The distribution system 110 may store third-party 3D virtual objects that are made available for distribution and placement in 3D environments. The system 110 enforces constraints on third-party 3D virtual objects that are eligible for distribution and placement in 3D environments. The constraints may ensure, for example, the portability of third-party 3D virtual objects so that they may be placed in an arbitrary 3D environment that is designed to accept arbitrary objects that comply with the constraints.

In some implementations, the distribution system 110 enforces constraints relating to the size and geometry of 3D models. The distribution system 110 may define a limited set of possible 3D models available to third-party content providers and 3D environment developers. For example, the set of possible 3D models may include cubes, spheres, cones, cylinders, and one or more other geometries. To create a compliant 3D object, third-party content providers may select a 3D model from among only the limited set of possible 3D models on which to present their third-party content. For instance, a third-party content provider may choose whether to place advertisements on a sphere or a cube, but may be restricted from defining a

custom 3D model. Each 3D model may be available in one or more sizes. The sizes may be pre-defined or may be specified by a developer or a third-party content provider. Alternatively, content providers may create custom 3D models for distribution that comply with any constraints imposed by the distribution system 110.

Developers may elect to incorporate third-party 3D virtual objects into a virtual environment as a means of monetizing the environment. By allocating space in the virtual environment for third-party content, the developers can expose an audience (e.g., end users / viewers of the 3D environment) to the third-party content. In exchange, third-party content providers may compensate, directly or indirectly, developers for the placement of third-party 3D virtual objects in the developers' 3D environments.

In some implementations, the amount charged to a third-party content provider for placing their content in a virtual 3D environment is based, at least in part, upon the volume of the third-party virtual 3D object that shows the content in the 3D environment. The content distribution system 110 may assign to a third-party 3D object a volume attribute that identifies the volume of the object. The volume attribute may control the size of the 3D object when it is placed and rendered in a 3D environment, and further may be applied to determine an amount charged to the third-party content provider for placement in the 3D environment. The volume attribute may be specified in cubic units such as cubic centimeters, cubic inches, cubic feet, cubic pixels, or other volumetric units. In some implementations, the amount that a third-party content provider is charged for placement of a 3D object showing third-party content is based on the actual volume of a 3D model for the object. In other implementations, the amount that a third-party content provider is charged for placement of a 3D object showing third-party content is based on the volume of a bounding box surrounding the 3D model for the object, where the

dimensions of the bounding box correspond to the maximum lengths of the 3D model along each dimension of the environment. For example, the amount charged to place a spherical 3D object may be based on the volume of the sphere itself or based on the volume of a cube having sides whose length is equal to the diameter of the sphere.

By charging third-party content providers based in whole or in part on the volume of 3D objects, a systematic approach to pricing third-party content in 3D environments may be implemented. The size and volume a 3D object in a 3D environment is generally indicative of the prominence of the object in the environment. Therefore, third-party content providers may be charged more to place larger, more prominent 3D objects in an environment or may be charged less to place smaller, less prominent 3D objects in the environment.

In some implementations, the distribution system 110 charges a fixed amount to place a given 3D object in a virtual 3D environment. The fixed amount is assessed based on the volume of the 3D object and, optionally, one, or more additional factors. Additional factors influencing the price may include, for example, the quality of the third-party content to be shown on the object, past performance of the third-party content, and technical characteristics of the object such as the complexity of the 3D model and resolution of images that are to be displayed on the model. In some implementations, the distribution system 110 may conduct online auctions that allow third-party content providers to bid on keywords or other criteria associated with 3D environments for which the providers desire 3D objects showing their third-party content to be placed in. The distribution system may select 3D objects to place in an environment, for example, that are associated with one or more highest bidders. The amount charged for a placed 3D object may be based on the bids and volume of the object. In some implementations, a winning third-party content provider (e.g., a highest bidder at an auction) is charged for each

impression or placement of a 3D object in a 3D environment. In other implementations, a winning third-party content provider may be charged only if a user interaction with the object in the 3D environment is detected, such as the user gazing at the placed object for a length of time, a user selecting the 3D object, or a conversion resulting from placement of the 3D object in the environment.

The distribution system 110 may alternatively allow the developer of a 3D environment, or a third-party content provider, to manually select which third-party content is to be shown on 3D objects placed in the 3D environment. The distribution system, for example, may include a database of available 3D objects submitted by a range of third-party content providers. The developer may access the database and select a 3D object with particular third-party content to place in the environment. In some implementations, third-party content providers may optimize 3D objects to be placed in 3D environments by rendering proposed 3D objects in test 3D environments that mimic conditions (e.g., lighting, object spacing) that are expected to occur in actual 3D environments in which the object may be placed.

Figure 2 is a view 200 of a cube-shaped virtual object 202 showing third-party content within a virtual 3D environment. The object 202 is textured with images that have been obtained using a third-party content distribution service. The object has dimensions h , l , and w , respectively, in three orthogonal directions of the environment. The distribution service may charge the provider of the third-party content based on the volume associated with the dimensions of the object 202.

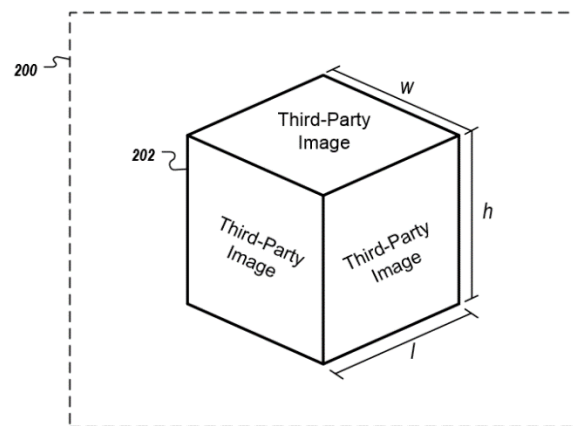
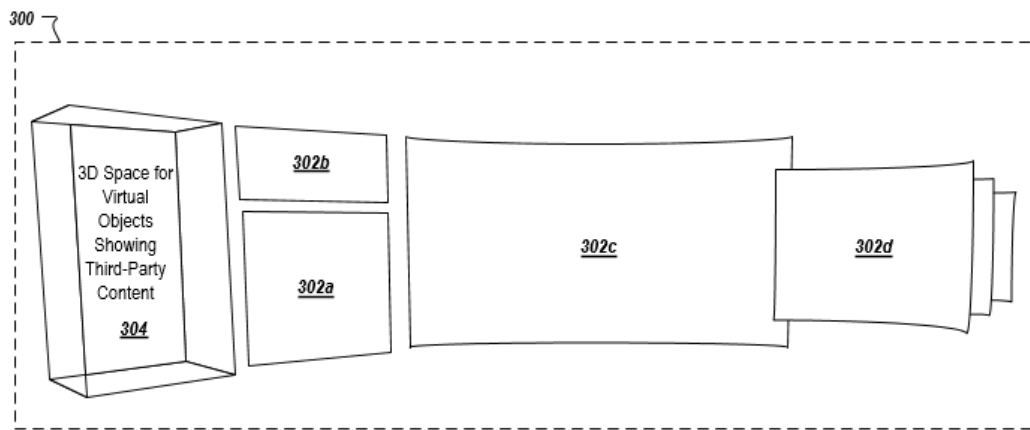


FIG. 2

Figure 3 is a view 300 of an arrangement of virtual objects 302a-d within a virtual 3D environment, where the environment includes a virtual space 304 designated for the display of third-party content. For example, the view 300 may be presented to a user through a head-mounted display. Each of the virtual objects 302a-d shows first-party content defined by a developer of the 3D environment. However, the virtual space 304 is configured to display a third-party virtual object. The developer may specify the dimensions of the space 304, and a content distribution system may select a third-party virtual object to present in the space 304 that substantially fills the space 304. A third-party content provider associated with the selected object may be charged based on the volume of the presented object or the volume of the space 304.

**FIG. 3**

ABSTRACT

A content distribution system facilitates the placement of third-party content in virtual, three-dimensional (3D) environments. The third-party content may be shown on virtual, 3D objects. The system defines a technical and financial framework by which developers of 3D environments can monetize their environments by allotting space for the display of third-party virtual objects. In some aspects, the content distribution system determines an amount to charge a third-party content provider for placing their content on a virtual object in a 3D environment based on the volume of the virtual object.