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Adjustable Conical Laser

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Abstract:

Techniques are described that enable a virtual laser pointer with an adjustable conical laser. The adjustable conical laser includes a main ray, like a conventional virtual laser pointer, but also provides a conical laser that expands the user's target area. When the user misses the intended target with the main ray, the VR system can use the cone to determine the likely target. If the cone intersects a single object, the VR system selects that object. If the cone does not intersect any objects, the VR system can expand the cone and determine if any objects intersect the expanded cone. If the cone intersects multiple objects, the VR system can determine the angles from the main ray to each intersection and select the object with the smallest angle. The angle of the conical laser can be manually adjusted to suit the user's preferences and the particular VR experience.

Keywords:

Virtual reality, laser pointer, shaped laser, cone, conical laser, virtual reality controls, user interface, controller accuracy

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.

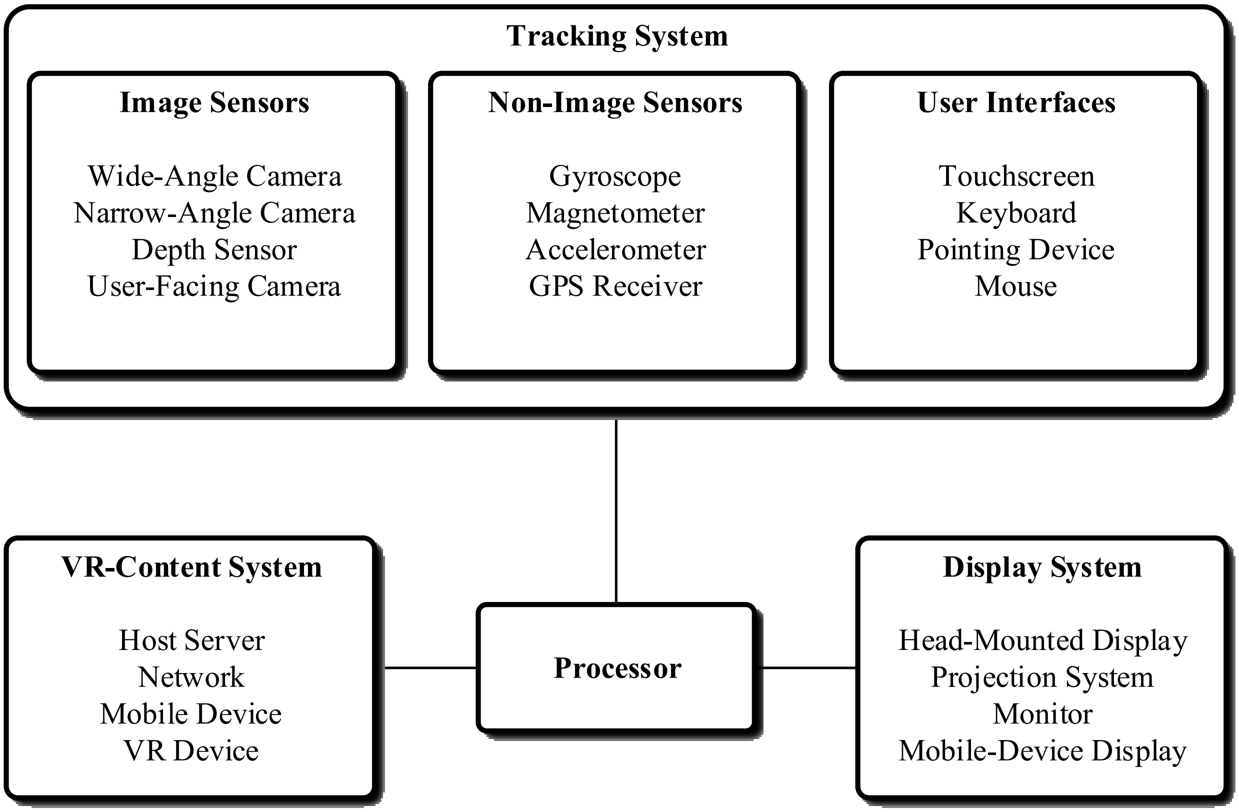

Fig. 1

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.

A particular configuration of the systems of Fig. 1 presents the user with a VR environment that includes a controller that allows the user to interact with objects in the VR environment (*e.g.*, a user interface as described with reference to the tracking system of Fig. 1). For example, the user may identify, activate, select, or grab objects using a laser pointer. While their use is common in VR environments, laser pointers are susceptible to a kind of input "noise" related to the user's ability to hold the VR controller still while trying to accurately target and select objects. This aiming problem can be particularly pronounced when the user is trying to target small objects or objects that are a large virtual "distance" from the user, and when the user is trying to target a single object in a group of objects that are close together. This situation is illustrated in Fig. 2, which shows a laser pointer emitting a ray (the green arrow) toward three objects that are relatively close together. As shown, the user may have aimed at the cube or the cylinder, but will instead hit the pyramid.

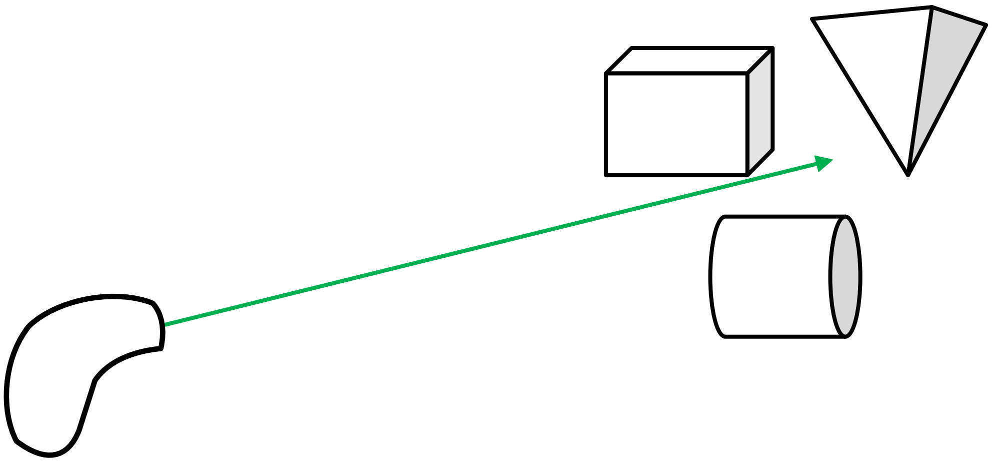

Fig. 2

The lack of accuracy in these situations may lead to frustration for the user. Some operations may have to be repeated because the wrong item is selected, and gaming performance may be degraded, which can reduce the quality of the VR experience.

Description:

To address these problems, techniques are described that enable a virtual laser pointer with an adjustable conical laser. The adjustable conical laser includes a main ray, like a conventional virtual laser pointer, but also provides a conical laser that expands the user's target area. When the user misses the intended target with the main ray, the VR system can use the cone to determine the likely target. If the cone intersects a single object, the VR system selects that object. If the cone does not intersect any objects, the VR system can expand the cone and determine if any objects intersect the expanded cone. If the cone intersects multiple objects, the VR system can determine the angles from the main ray to each intersection and select the object with the smallest angle. The angle of the conical laser can be manually adjusted to suit the user's preferences and the particular VR experience.

In some VR implementations, the adjustable conical laser is a virtual laser that is generated by a VR controller that the user is holding. The virtual laser can simulate the effect of a real laser pointer by using the positions of the user, the controller, and the targets calculate the direction the virtual laser is pointed. In other VR implementations, or in an augmented reality (AR) implementation, a real laser pointer may be used to generate the adjustable conical laser.

Fig. 3 illustrates an example implementation of a laser pointer with an adjustable conical laser. In the example of Fig. 3, the main ray is shown as a green arrow, the conical laser is shown with an orange dashed line, and an expanded cone is shown with a violet dotted line.

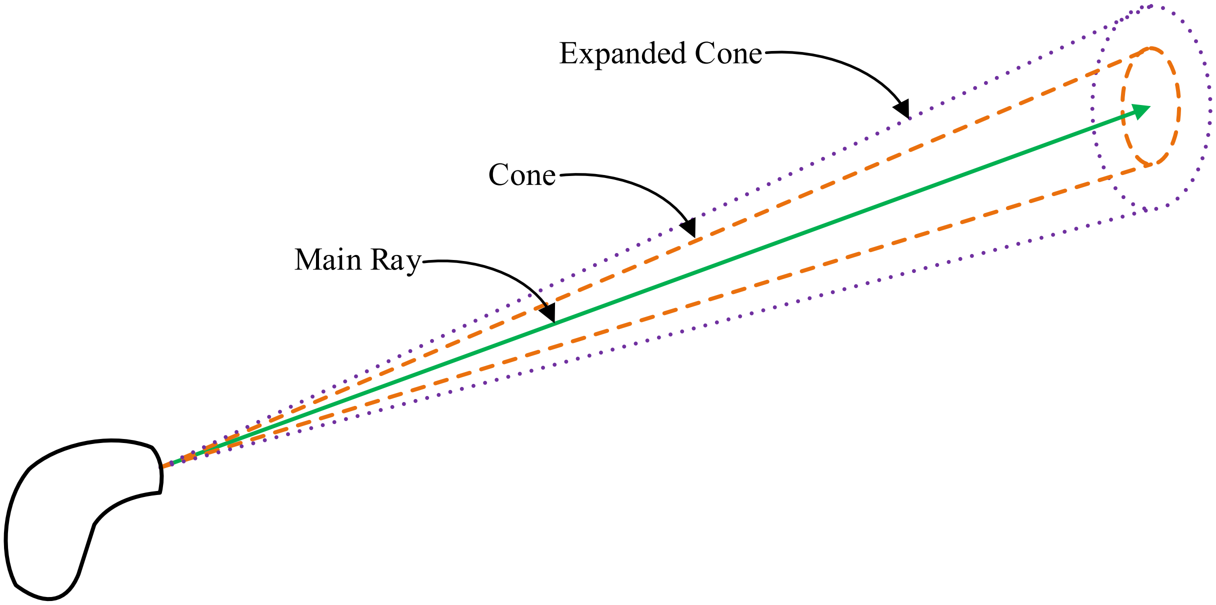

Fig. 3

Fig. 4 is a flow chart that illustrates how the adjustable conical laser can assist the VR system in determining whether an object has been selected. To start the process, a laser pointer emits a ray that includes a cone and a main ray. The VR system then determines how many objects intersect the main ray. If only one object intersects the main ray, the VR system selects that object. If the main ray intersects multiple objects, the VR systems finds the distance from the ray origin point (the laser pointer) and selects the nearest intersected object. This is illustrated in Fig. 5-1.

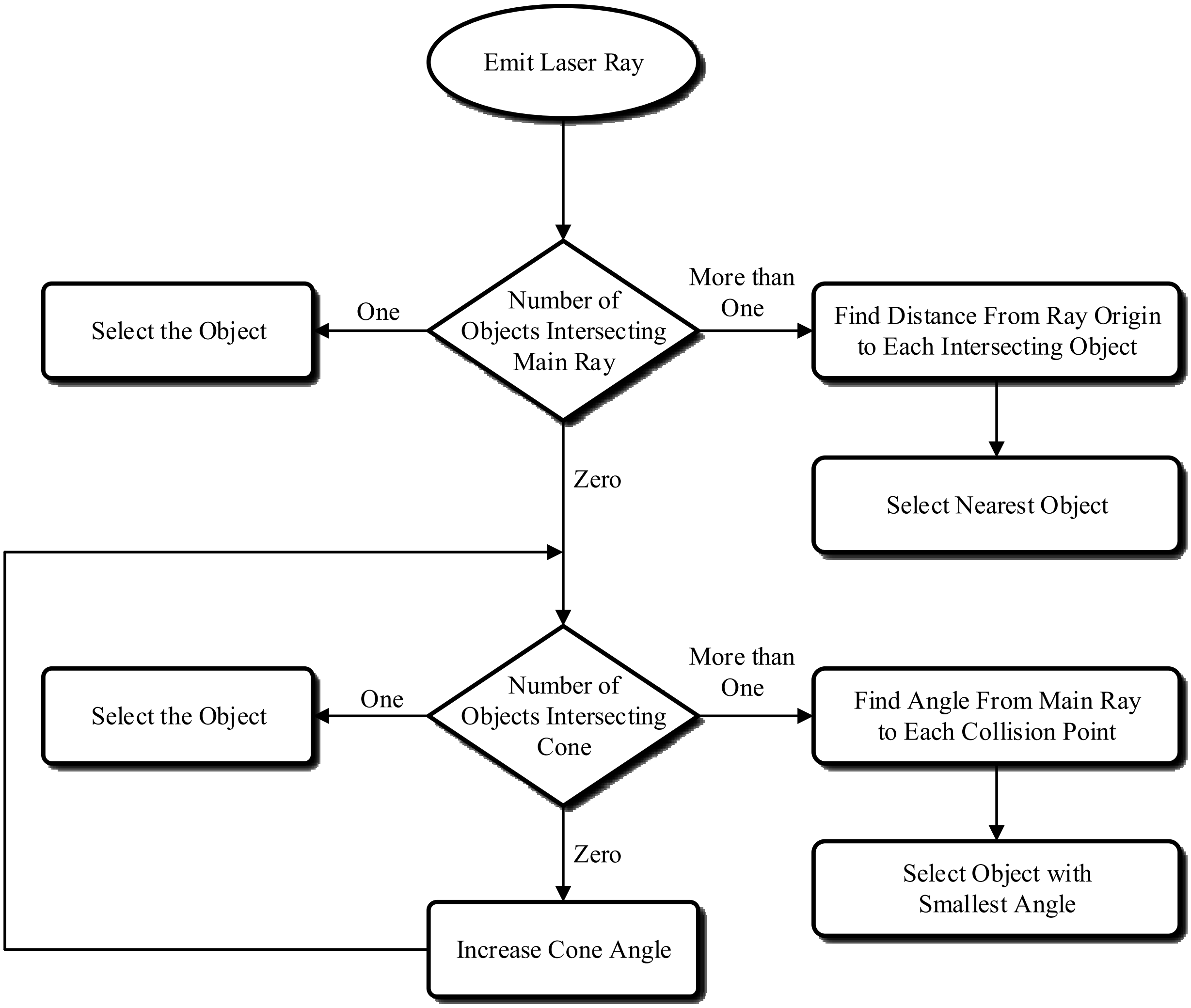
Emit Laser Ray
Select the Object
One
Number of Objects Intersecting Main Ray
More than One
Find Distance From Ray Origin to Each Intersecting Object
Select Nearest Object
Zero
Select the Object
One
Number of Objects Intersecting Cone
More than One
Find Angle From Main Ray to Each Collision Point
Select Object with Smallest Angle
Zero
Increase Cone Angle

Fig. 4

If the main ray does not intersect any objects, the VR system determines how many objects intersect the cone. If only a single object intersects the cone, the VR system selects that object. If the cone intersects multiple objects, the VR systems finds the angle from the main ray to each intersection and selects the object with the smallest angle. This is illustrated in Fig. 5-2. If the cone does not intersect any objects, the VR system may expand the angle of the cone and repeat the process of determining whether the cone intersects one, more than one, or zero objects. This is illustrated in Fig. 5-3. In some implementations, if the cone does not intersect any objects, the VR system may determine that the user did not intend to select any objects.

Fig. 5-1 illustrates an example of the main ray intersecting more than one object. Fig. 5-1 shows a side view of the main ray (green arrow) intersecting both the cube and the cylinder. The VR system can determine a distance (d1) from the laser pointer to the cube and a distance (d2) from the laser pointer to the cylinder. In this example, d1 is less than d2 and the VR system selects the cube.

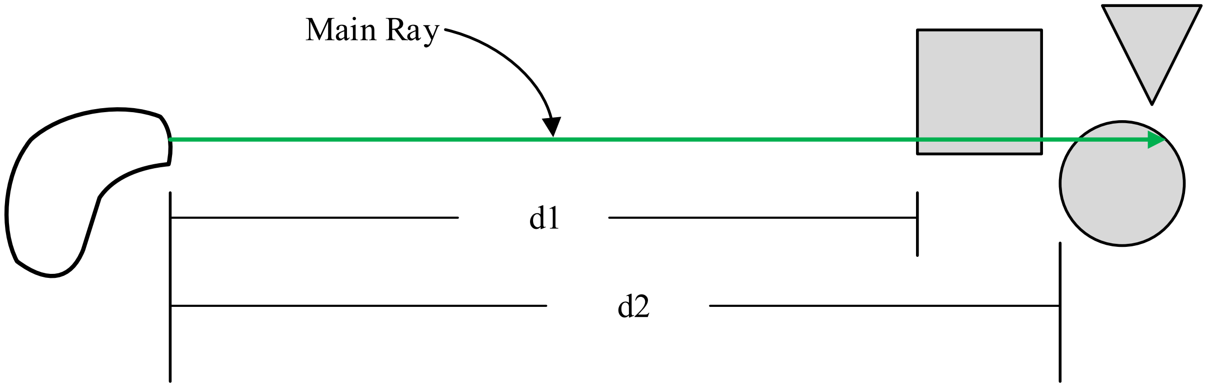

Fig. 5-1

Fig. 5-2 illustrates an example of the cone intersecting more than one object. Fig. 5-2 shows a side view of the cone (orange dotted line) intersecting both the pyramid (a triangle in the side view) and the cylinder (a circle in the side view). The VR system can determine an angle (α1) from the main ray to the pyramid and an angle (α2) from the main ray to the cylinder. In this example, α1 is smaller than α2 and the VR system selects the pyramid.

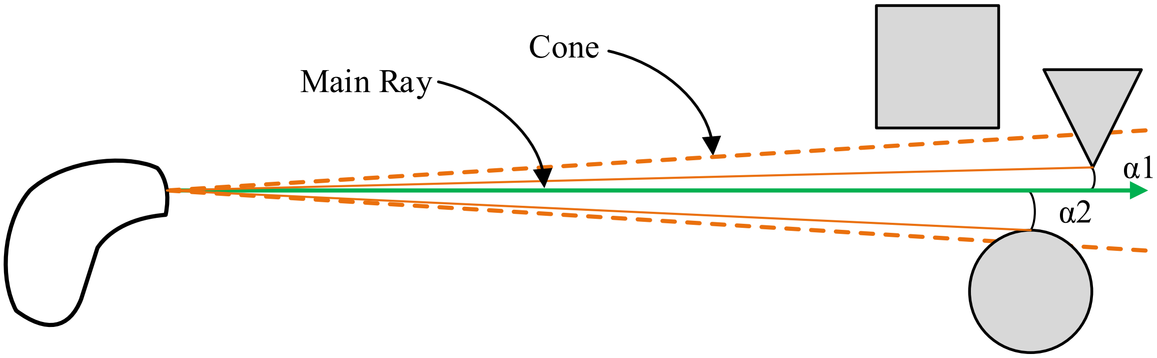

Fig. 5-2

Fig. 5-3 is a side view of a laser pointer with an expanded cone (violet dotted line) with a wider angle than the original cone (orange dashed line).

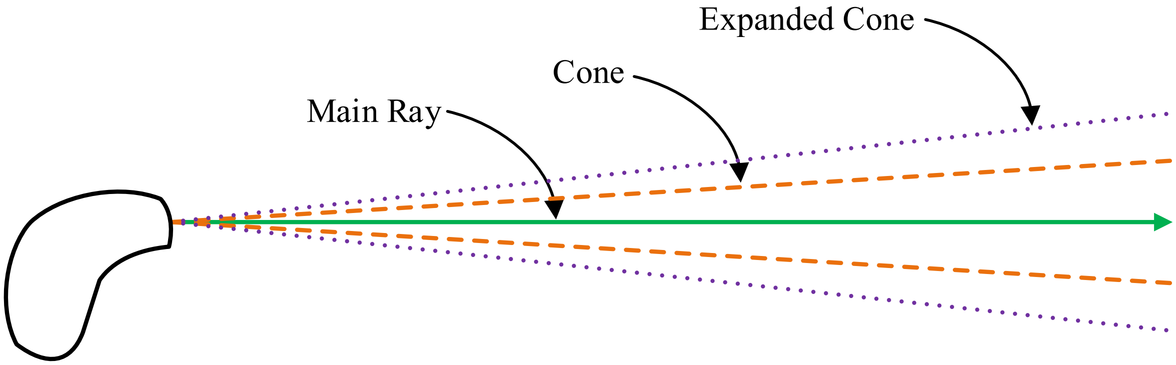

Fig. 5-3

The adjustability of the angle of the cone may be manual or automatic. For instance, the user may select a wider angle when learning a new game and then decrease the angle as proficiency increases. In one path shown in the flow chart of Fig. 4, the cone does not intersect any objects and the cone angle is increased. In this case, the VR system may increase the angle automatically until it either makes contact with an object or determines that the user is not trying to point at an object. The expansion may be repeated a predetermined number of times or until the angle of the cone reaches a predetermined maximum value. Both the number of expansions and the maximum angle may be user-selectable.