Meta Platforms, Inc., Meta Platforms Technologies, LLC, And Twisted Pixel Games, LLC (Petitioners) v. Eight kHz, LLC (Patent Owner)

IPR2023-01023 (US Patent 10,798,509)

Petitioners' Demonstratives

October 17, 2024

Agenda

- Overview
- Ground 1: Pedrotti, Jang, and Begault Render The Challenged Claims Obvious
- Ground 2: McCulloch, Pedrotti, and Flaks Render The Challenged Claims Obvious

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Overview

Ground 1: Pedrotti, Jang, and Begault Render The Challenged Claims Obvious

Ground 2: McCulloch, Pedrotti, and Flaks Render The Challenged Claims Obvious

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Overview

Ground 1: Pedrotti, Jang, and Begault Render The Challenged Claims Obvious

Ground 2: McCulloch, Pedrotti, and Flaks Render The Challenged Claims Obvious

Overview Of Pedrotti

Pedrotti

In still another embodiment, an irregularly shaped area is defined, as shown in FIG. **14**. A boundary **1404** around an irregularly shaped area, which is not circular, can be defined, for example, by having the user walk around a perimeter chosen by the user with one of the trackers to define the outer boundary of a selected area, for example, one in which there are no obstacles. The processor determines the position of the tracker at a number of sampling points as the user moves around the chosen perimeter, and from those points determines the boundary **1404**. This approach may be desirable

Ex. 1005 (Pedrotti) at 14:56-65

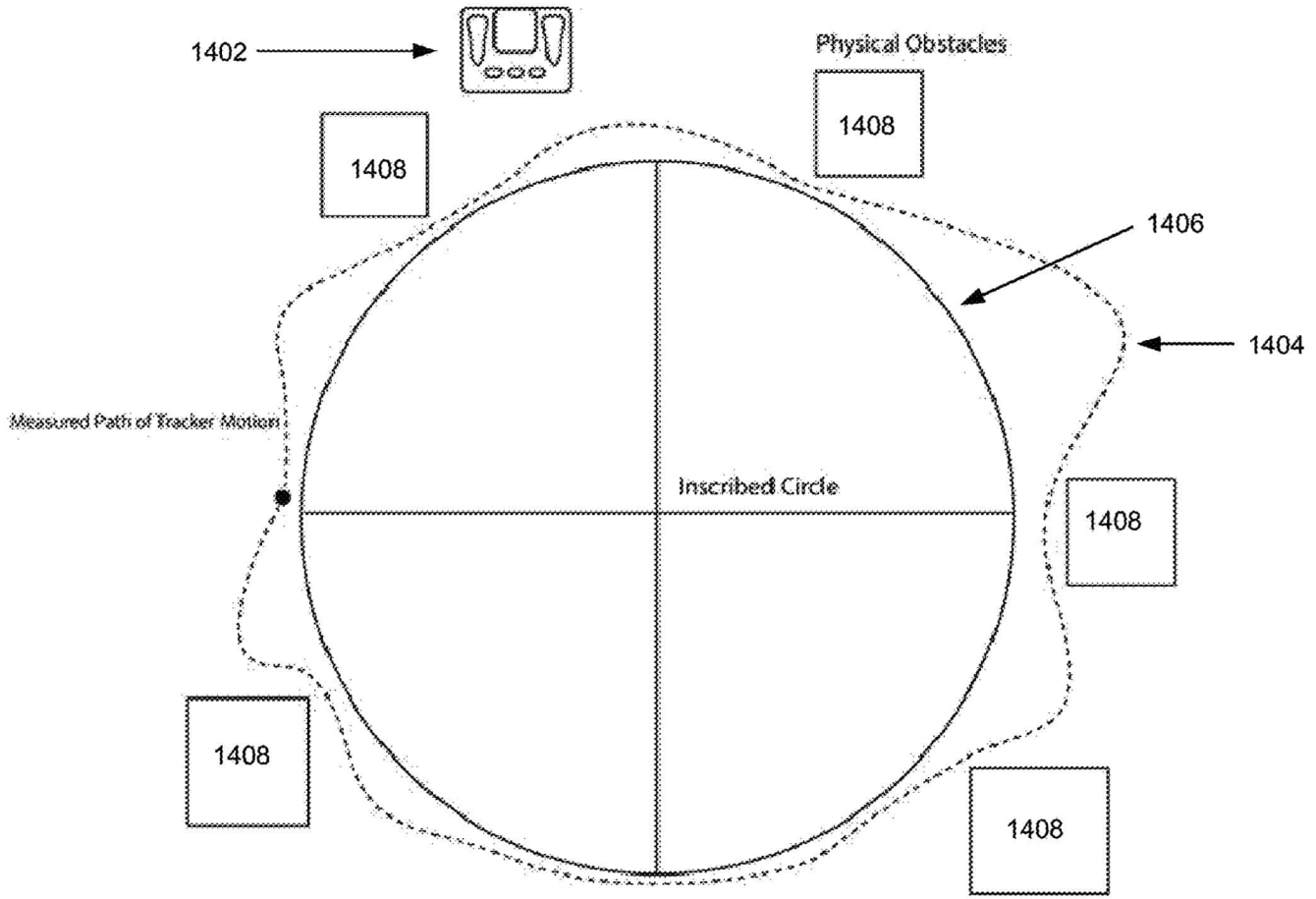


Figure 14

Ex. 1005 (Pedrotti) at Fig. 14

Overview Of Pedrotti

Pedrotti

FIG. **11** shows one such form of visual warning. In FIG. **11** it is assumed that the user **1002** is holding a controller with a tracker in the hand corresponding to virtual hand **1012**, and that the user **1002** has extended that hand to a point within the preselected distance from the boundary of the selected area. The display in FIG. **11** is similar to that of FIG. **10**, except that since the user **1002** has extended his hand holding the controller, the virtual hand **1012** now extends further in front of the user **1002**.

In addition, since the hand of the user **1002** is within the preselected distance of the boundary of the selected area, the processor generates instructions to the HMD to generate the visual warning. As illustrated in this embodiment, this visual warning is in the form of a grid of lines or a "virtual fence" located at the boundary, as indicated in FIG. **11** by the dashed lines **1114**. The grid can be glowing or colored if desired to be more visible to the user. In other embodiments, other shapes than a grid-shaped virtual fence can be displayed to the user. For example, the developer of a particular

Ex. 1005 (Pedrotti) at 12:51-13:2

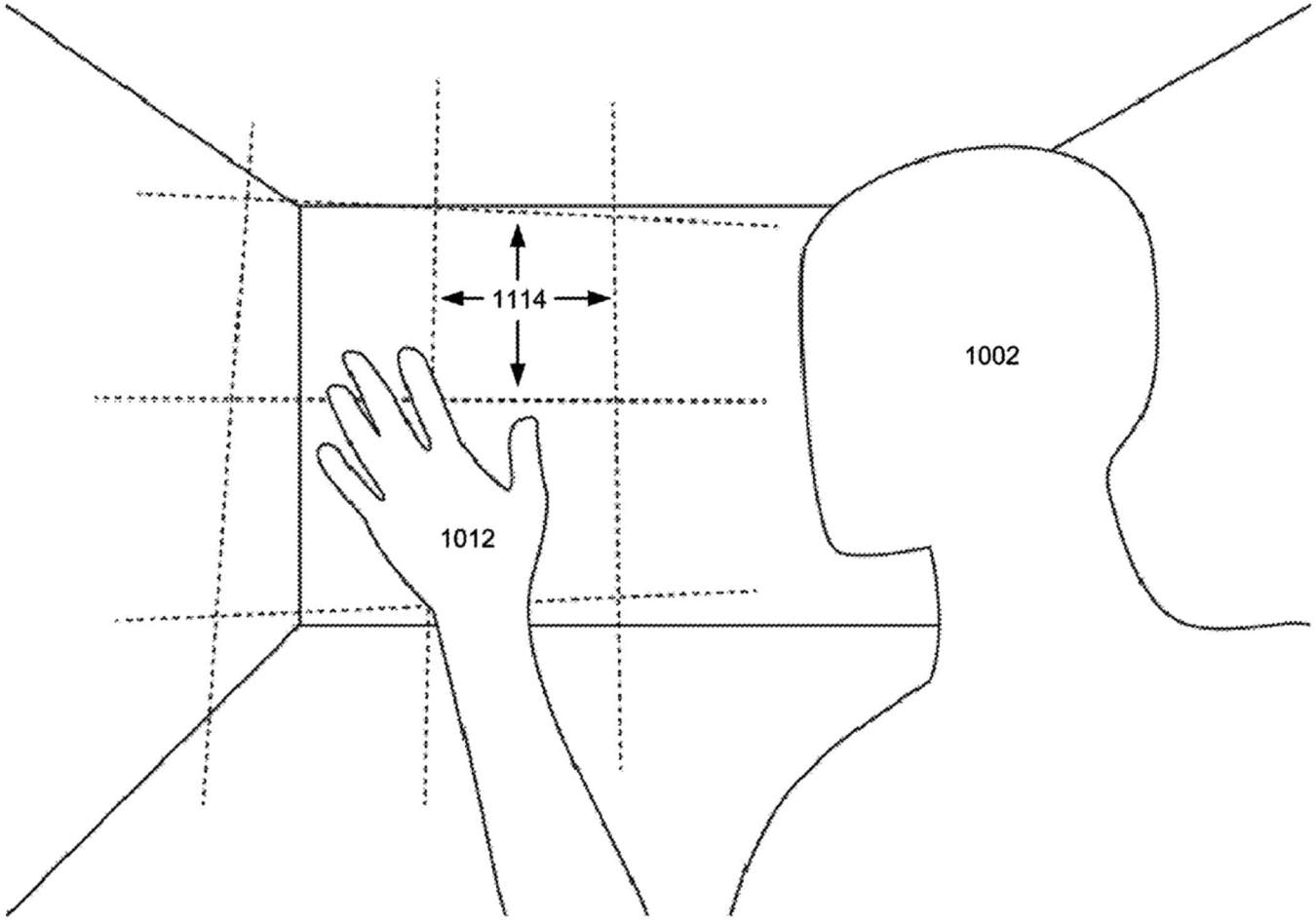


Figure 11

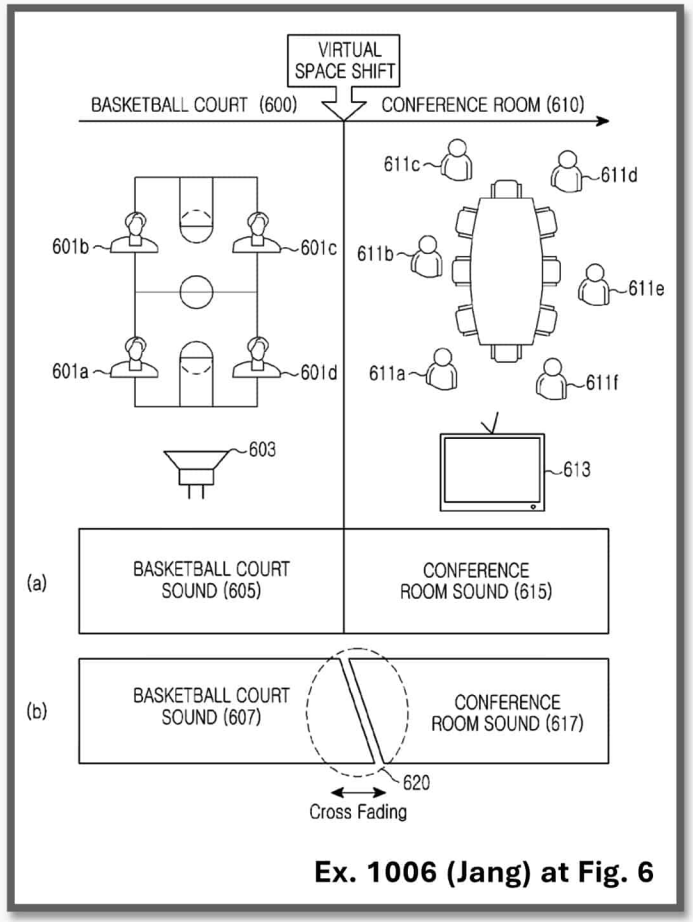
Ex. 1005 (Pedrotti) at Fig. 11

Overview Of Jang

Jang

In this situation, the virtual reality apparatus may divide the virtual reality space into a focus area within the visual field of the character using the virtual reality apparatus and non-focus areas outside the visual field of the character. The focus area within the visual field of the character refers to an area **203** (shaded portion) adjacent to the character **200** in the front space within the visual field of the character **200**. The non-focus areas beyond the visual field of the character include an area **201** relatively distanced far from the character **200** in the front space within the visual field of the character **200** and areas **205**, **207**, **209**, and **211** located outside the visual field of the character **200**. The division between the focus area and the non-focus areas in FIG. **2** is only an example and may be modified in various ways according to the characteristics and/or topography of the virtual area at which the character is located in the virtual reality space. For example, while the dividing of sound areas is described with respect to a character **200** and companions **220**, **230**, and **240**, the "companions" need not be players or personages. Rather, each divided focus or non-focus area may contain any number of virtual objects represented by sensory data that may include audio and visual data, for example. Further, at least one of the focus area and the non-focus areas may be divided into multiple areas in the virtual reality space according to a predetermined priority in controlling the volume of the sound or the left-right balance.

Ex. 1006 (Jang) at 8:25-49



Ex. 1006 (Jang) at Fig. 6

Overview Of Begault

Begault

Computer Workstation 3-D Audio
A Generic Example

A simple audio equivalent to the graphic user interface (GUI) as described previously is only marginally useful. The concept of a computer workstation as not only a location for editing documents but also for **communicating** with databases and persons within the office adds a new dimension to the possibilities for 3-D sound. For instance, telephone communication can be handled though a computer via functions such as message recording and dialing. If the audio signal is brought into the computer and then spatialized, the communication source can be usefully arranged in virtual space. This feature becomes particularly important in multiconversation **teleconferencing**, where video images of the participants can be broadcast on the screen. Spatial audio teleconferencing has been described as an **audio window** system by Ludwig, Pincever, and Cohen (1990).

* * *

Figure 5.12 shows a hypothetical GUI for arranging these various sound inputs in virtual auditory space in a manner configurable by each individual listener. The basic concept is to represent each form of auditory input iconically on the screen and then allow manipulation of the distance and relative azimuth of each source. The computer interprets the relative location of the icons on the screen as commands to a multiinput, 3-D sound spatialization subsystem.

Ex. 1007 (Begault) at 172

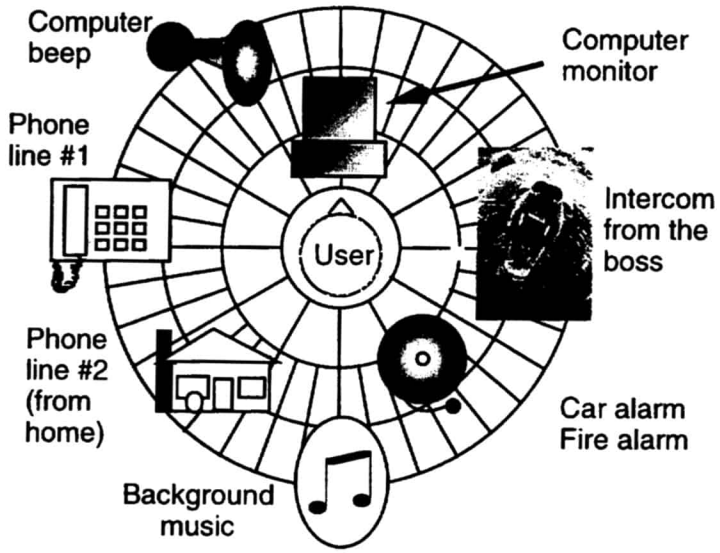


Figure 5.12. Layout for a hypothetical GUI for arranging a set of incoming sounds. By resizing the icons, volume could be adjusted independently of perceived distance. *Graphic assistance by Denise Begault.*

Ex. 1007 (Begault) at Fig. 5.12

Motivations To Combine: Pedrotti And Known Sound-Processing Techniques

Pedrotti

Virtual reality is often used to describe a wide variety of applications commonly associated with immersive, highly visual, computer-simulated environments that can simulate a user's physical presence in places in the real world or imagined worlds. While virtual reality can recreate a number of sensory experiences, the senses most commonly used today to create virtual reality appear to be sight and sound.

Ex. 1005 (Pedrotti) at 1:14-20

Jang

Virtual reality systems allow users to feel various manufactured sensory inputs (including visual sense, auditory sense, and tactile sense) in a virtually formed space. The sensory inputs may replicate sensory experiences of the real world with varying degrees of realism. For example, in a virtual reality game, life-like images and sounds may be generated, but a game joystick or controller may only roughly imitate a real-life sensation of contact by vibrating. An image of a virtual reality system may be three-dimensionally realized by using a monitor, a Head Mounted Display (HMD), a television, a projector, or any other visual display device. Further, the sound of the virtual reality system may use a localization technique capable of expressing the virtual location. Sound of a virtual reality system may be generated by speakers, a headset, or any other audio device.

Ex. 1006 (Jang) at 1:31-45

Begault

So What Is 3-D Sound Good For?

If we want to improve the quality and ease of interaction within a human interface, communication system, or office or home environment, it is impossible to ignore the sense of hearing. To control the audio sensations of a human user in a positive way requires examining all aspects of human sensitivity to sound. The fact that audio in the real world is heard spatially is the initial impetus for including this aspect within a simulation scenario. For a desirable audio interface, this fact can be combined along with criteria for eliminating the fatiguing aspects of **noise** and **distortion.** In some circumstances, control over these quality issues can make a human interface a safer environment. While this has been recognized for the visual and physical parameters of human usage (VDT screens and wrist supports, for example), the notion of what constitutes a positively human interfaced audio display—i.e., an audio display **ecology**—has been late in coming to the computer.

3-D sound can contribute to the sense of immersivity in a 3-D environment. One might be able to work more effectively within a VR environment if actions were accompanied by appropriate sounds that seemingly emit from their proper locations, in the same way that **texture mapping** is used to

Ex. 1007 (Begault) at 13

'509 Patent, Limitation 9[pre] (Ground 1)

9[pre]	A non-transitory computer readable storage medium storing instructions that one or more electronic devices execute as a method, the method comprising:
9[a]	dividing, with a portable electronic device (PED) held in a hand of a user, an area around the user into a zone that includes sound localization points (SLPs) in empty space from where binaural sound originates to the user;
9[b]	determining, with a wearable electronic device (WED) worn on a head of the user, when the user is located inside the zone;
9[c]	determining, with the WED worn on the head of the user, when the user is leaving the zone; and
9[d]	displaying, with the WED worn on the head of the user, a three dimensional (3D) virtual image of the zone in response to the WED determining that the user is leaving the zone.

Pedrotti Discloses A Non-Transitory Computer Readable Storage Medium

Pedrotti

Still another embodiment discloses a non-transitory computer-readable medium having embodied thereon a program, the program being executable by a processor to perform a method of assisting a user wearing a head-mounted display (HMD) in remaining within a selected area of the physical world, the user holding a handheld controller having a controller tracker which provides information regarding a position and orientation of the controller, the method comprising the steps of: receiving, by a processor as an input, a definition of a boundary of the selected area; determining, by the processor, the position of the handheld controller in the physical world using information from the controller tracker; generating and outputting, by the processor, instructions to the HMD to display on the HMD a virtual world; determining, by the processor, from the position of the handheld controller that the handheld controller is within a first preselected distance from the boundary; generating and outputting, by the processor, instructions to the HMD to display on the HMD a first visual warning in the virtual world.

Ex. 1005 (Pedrotti) at 2:60-3:12

'509 Patent, Limitation 9[a] (Ground 1)

9[pre]	A non-transitory computer readable storage medium storing instructions that one or more electronic devices execute as a method, the method comprising:
9[a]	dividing, with a portable electronic device (PED) held in a hand of a user, an area around the user into a zone that includes sound localization points (SLPs) in empty space from where binaural sound originates to the user;
9[b]	determining, with a wearable electronic device (WED) worn on a head of the user, when the user is located inside the zone;
9[c]	determining, with the WED worn on the head of the user, when the user is leaving the zone; and
9[d]	displaying, with the WED worn on the head of the user, a three dimensional (3D) virtual image of the zone in response to the WED determining that the user is leaving the zone.

Pedrotti's Zone Is Defined By The Controller

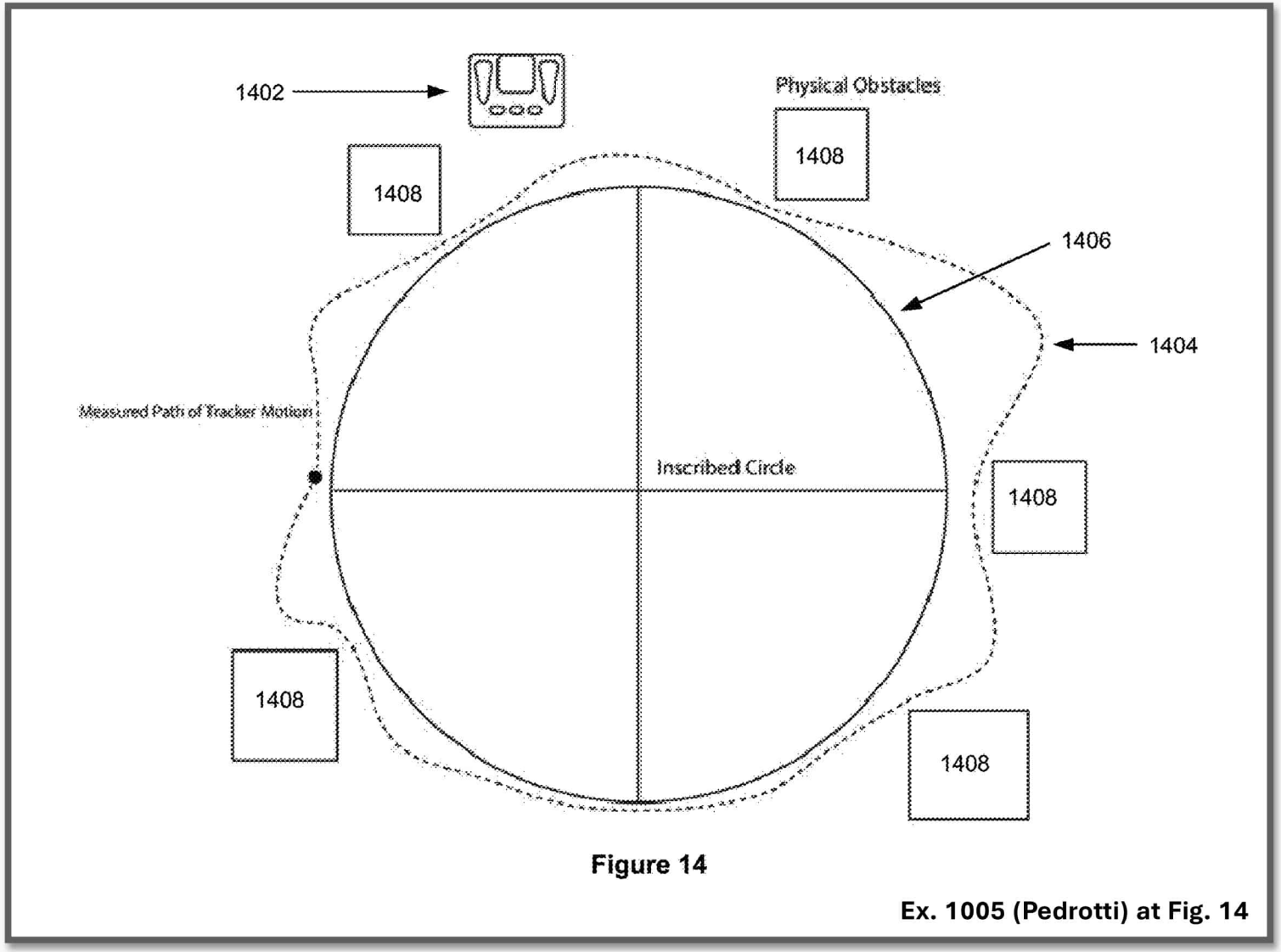


Figure 14

Ex. 1005 (Pedrotti) at Fig. 14

Pedrotti's Zone Is Defined By The Controller

Pedrotti

As above the processor is tracking the position and orientation of the user's head from the tracker of the HMD, and possibly tracking the position and orientation of the user's hand if the user is holding a controller with a tracker. Thus, the processor knows where the user's head and hands are located; if the processor has been provided with information about the boundary of the selected area then the processor can also determine when the user's head and/or hand approaches the boundary.

* * *

In still another embodiment, an irregularly shaped area is defined, as shown in FIG. **14**. A boundary **1404** around an irregularly shaped area, which is not circular, can be defined, for example, by having the user walk around a perimeter chosen by the user with one of the trackers to define the outer boundary of a selected area, for example, one in which there are no obstacles. The processor determines the position of the tracker at a number of sampling points as the user moves around the chosen perimeter, and from those points determines the boundary **1404**. This approach may be desirable

Ex. 1005 (Pedrotti) at 12:31-39, 14:56-65

Pedrotti Renders Obvious A Zone Including SLPs In Empty Space

Pedrotti

The processor can continue to generate instructions to the display in the HMD to present the user with changes in the virtual world based upon actions that the user has performed with one or both of the physical controllers. In a conventional video game, for example, a user may use a controller to have a character on a television screen "pick up" a weapon displayed on the screen. Similarly, with the present approach the processor can cause a HMD to display a virtual weapon while the user is in a virtual world. Then, upon the user's extending his or her physical hand(s) in such a way as to cause the corresponding virtual hand(s) to "reach for" the displayed virtual weapon and the user's activating a proper command (e.g., by pressing a button on the controller), the processor can cause the HMD to display the user's virtual hand(s) **214** as "picking up" and holding that virtual weapon.

Ex. 1005 (Pedrotti) at 9:26-40

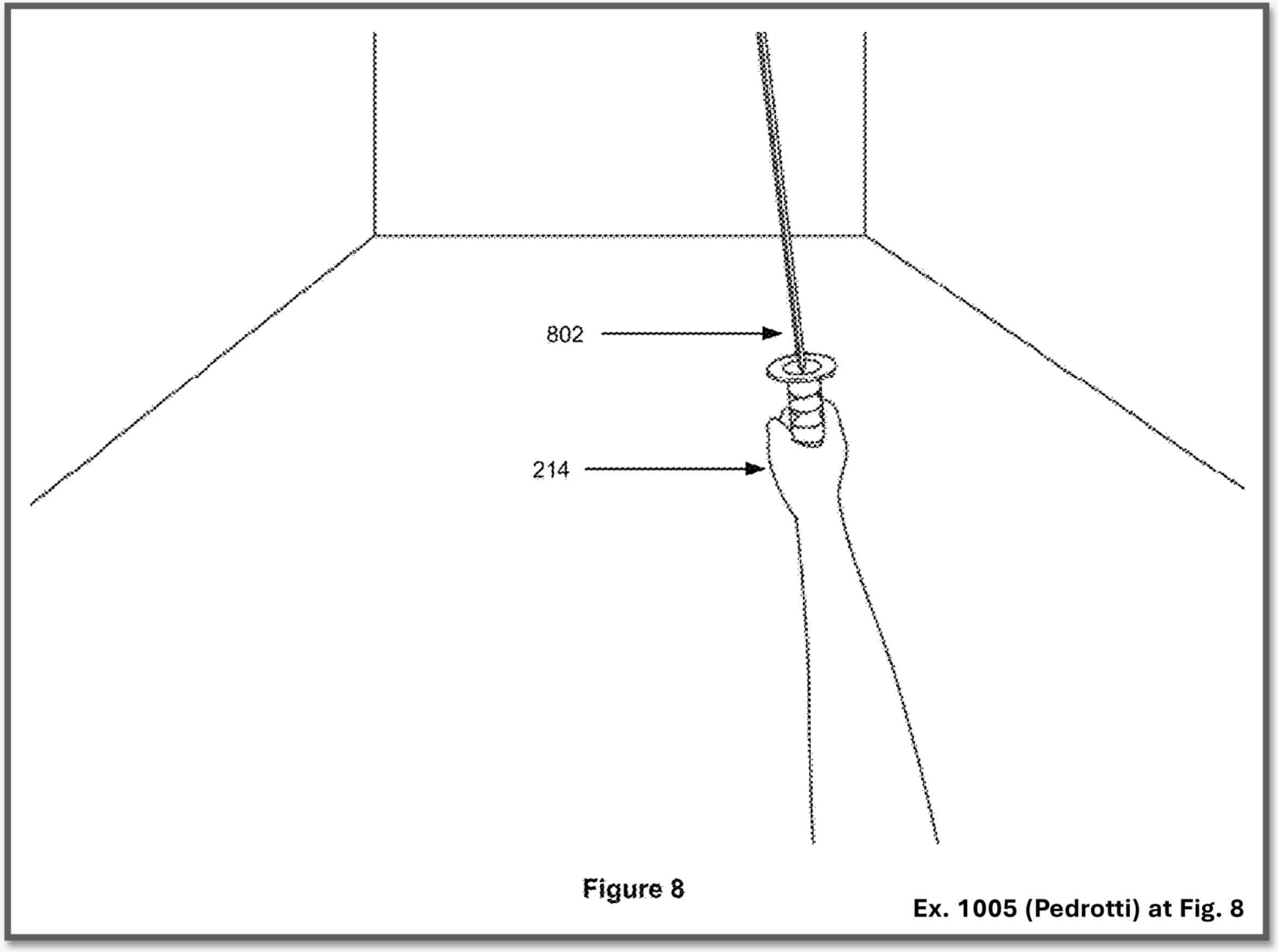


Figure 8

Ex. 1005 (Pedrotti) at Fig. 8

Jang Renders Obvious Zones Including SLPs In Empty Space

Jang

The control unit **104** may receive an input of a selected virtual reality character from the user to which the virtual reality environment is provided, check sound source information on other characters and other objects existing in the virtual reality spaces already stored in the storage unit **102**, and provides the virtual reality apparatus **110** with sound sources occurring in real time according to the relative locations or situations of the character in the virtual reality environment. In FIG. **1**B, the communication unit **106** transfers the sound sources delivered through the control unit **104** to the virtual reality apparatus **110** according to a predetermined communication scheme. The communication unit **106** may use various wire and wireless communication schemes applicable to the virtual reality system.

Ex. 1006 (Jang) at 7:24-37

Jang

The first and second sensory sources may be audio sources.

The focus area may correspond to an area in the virtual environment in the immediate foreground of a visual perspective of a character corresponding to a user, and the non-focus area may correspond to an area that is not in the immediate foreground of the visual perspective of the character.

The method may further include determining whether there are a plurality of sensory sources in the focused area, and if it is determined that there are a plurality of sensory sources in the focused area, determining a priority of each of the plurality of sensory sources in the focused area and adjusting an output of each of the plurality of sensory sources in the focused area based on a respective priority.

Ex. 1006 (Jang) at 4:19-32

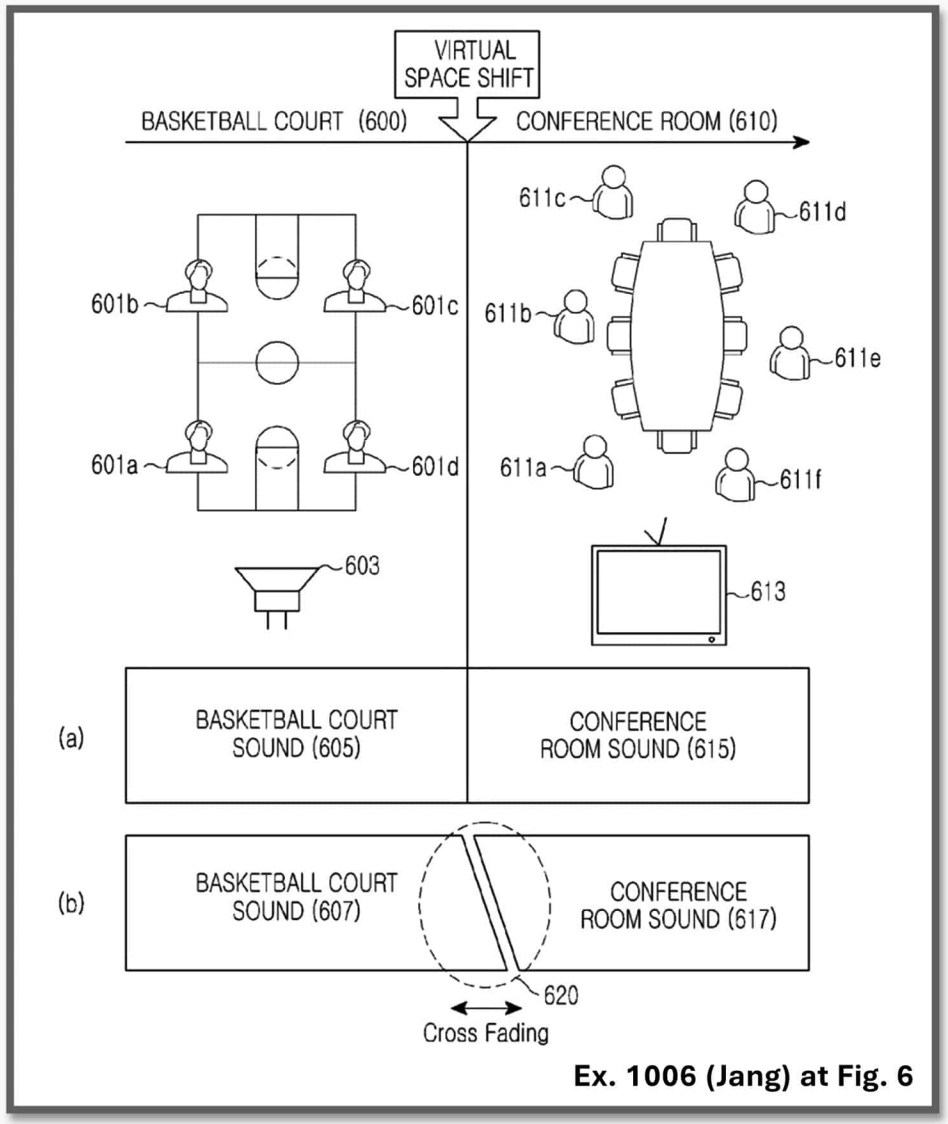
Jang Renders Obvious Zones Including SLPs In Empty Space

Jang

For example, if a user's character moves from a basketball court to a conference room, visual, audio, or tactile elements of the basketball court may decrease in magnitude, and visual, audio, or tactile elements of the conference room may begin to be transferred to a virtual reality device or a portion of the virtual reality device. Transferring the sensory output data of the second space may include transferring data from a source outside the virtual reality device or from a storage unit within the virtual reality device to a control unit.

When transferring the sensory output data of the second space, the sensory output data is first divided into a focus area and non-focus areas, as described above. Upon being transferred, the sensory data corresponding to the focus area of the second space is output as sensory output **833**. Meanwhile, the sensory data corresponding to the non-focus area or areas of the second space may begin to be transferred. Once sufficient sensory data corresponding to the non-focus area or areas has been transferred, the sensory non-focus area sensory data may be mixed with the focus area sensory data and output as sensory output **833**.

Ex. 1006 (Jang) at 11:64-12:16



Ex. 1006 (Jang) at Fig. 6

Begault Likewise Renders Obvious Zones Including SLPs In Empty Space

Begault

Consider all of the possible audio inputs to a workstation user, not only teleconferencing environments, but all types of sonic input. All types of sonic input could be directionalized to a specific location, controlled by the user. Furthermore, it is not necessary to place these audio sources in their corresponding visual locations; the audio spatial mapping can correspond to a **prioritization** scheme. For telephone calls, spatialization of incoming rings will become interesting when the caller can be identified. In such a scenario, calls from subordinates could be signaled by a phone ringing from the rear; a call from home could always ring from front right; and the intercom from the boss could be from front and center. In this case, spatial location informs the listener as to the prioritization for answering calls—whether or not to put someone on hold, or to activate a phone mail system.

Ex. 1007 (Begault) at 172

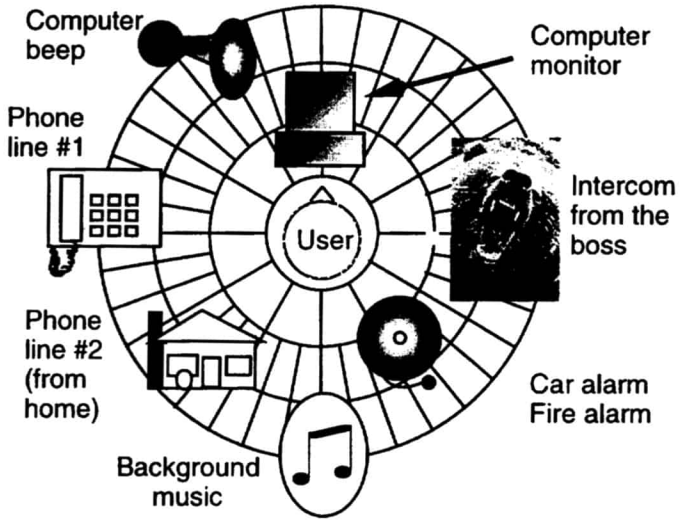


Figure 5.12. Layout for a hypothetical GUI for arranging a set of incoming sounds. By resizing the icons, volume could be adjusted independently of perceived distance. *Graphic assistance by Denise Begault.*

Ex. 1007 (Begault) at Fig. 5.12

'509 Patent, Limitations 9[b] And 9[c] (Ground 1)

9[pre]	A non-transitory computer readable storage medium storing instructions that one or more electronic devices execute as a method, the method comprising:
9[a]	dividing, with a portable electronic device (PED) held in a hand of a user, an area around the user into a zone that includes sound localization points (SLPs) in empty space from where binaural sound originates to the user;
9[b]	determining, with a wearable electronic device (WED) worn on a head of the user, when the user is located inside the zone;
9[c]	determining, with the WED worn on the head of the user, when the user is leaving the zone; and
9[d]	displaying, with the WED worn on the head of the user, a three dimensional (3D) virtual image of the zone in response to the WED determining that the user is leaving the zone.

Pedrotti Discloses Determining, With The WED, When The User Is Located Inside The Zone

Pedrotti

As above the processor is tracking the position and orientation of the user's head from the tracker of the HMD, and possibly tracking the position and orientation of the user's hand if the user is holding a controller with a tracker. Thus, the processor knows where the user's head and hands are located; if the processor has been provided with information about the boundary of the selected area then the processor can also determine when the user's head and/or hand approaches the boundary.

* * *

There may be a single processor, or multiple processors performing different functions of the functions described herein. As above, a processor may be located in the base station, or in a separate location, or even in the HMD or one of the controllers if desired. One of skill in the art will appreciate how to determine which and how many processors will be appropriate for a specific intended application.

Ex. 1005 (Pedrotti) at 12:35-39, 16:20-26

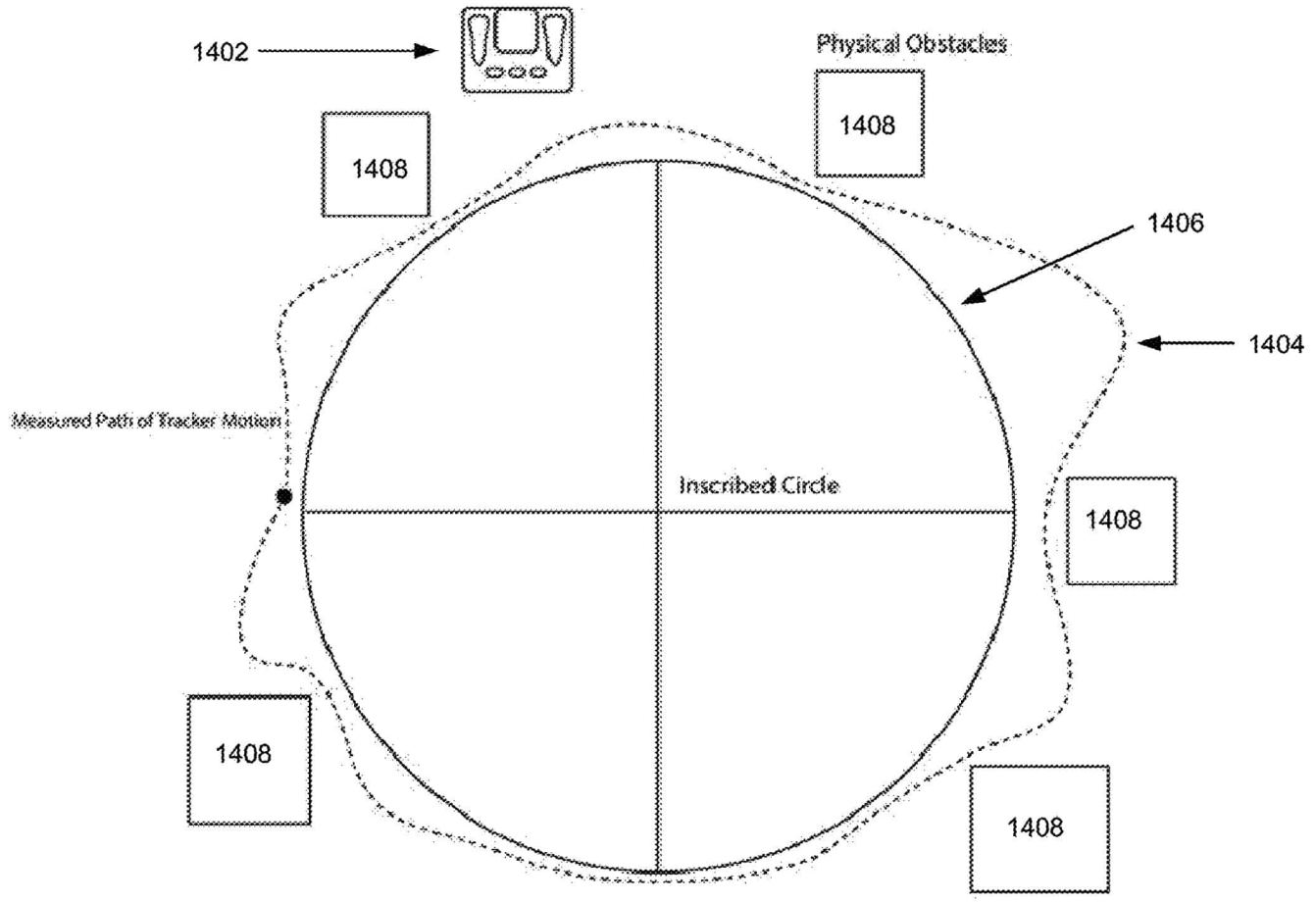


Figure 14

Ex. 1005 (Pedrotti) at Fig. 14

Pedrotti Discloses Determining, With The WED, When The User Is Leaving The Zone

Pedrotti

Another such example are light-emitting trackers which can be seen by, and therefore provide position and orientation information to, a camera mounted on the base station or elsewhere. Other forms of trackers, including those incorporating inertial sensors (e.g., accelerometers and/or gyroscopes), can likewise be used in the present approach. As would be understood by one of ordinary skill in the art in light of the teachings herein, essentially any type of tracker (e.g., magnetic, optical, electrical, sonar, radar, ultrasonic, or any combination thereof) which can provide information regarding its position (and, in some cases, orientation, if needed or desired) can be used in the present approach. Such techniques are all contemplated as being within the described system and method, including techniques which can only provide position information, and not orientation, even though the below discussion generally refers to electromagnetic tracking.

Ex. 1006 (Pedrotti) at 5:8-24

Pedrotti

If the user's head or hands go beyond the boundary as determined by the trackers, the processor can provide additional messaging or warning, such as text or auditory warnings, or an additional visual warning, that persists until the user returns to the selected area within the boundary. In

Ex. 1006 (Pedrotti) at 13:63-67

Limitations 9[b] And 9[c]: "Determining, With The WED …"

'509 Patent

9. A non-transitory computer readable storage medium storing instructions that one or more electronic devices execute as a method, the method comprising:

dividing, with a portable electronic device (PED) held in a hand of a user, an area around the user into a zone that includes sound localization points (SLPs) in empty space from where binaural sound originates to the user;

determining, with a wearable electronic device (WED) worn on a head of the user, when the user is located inside the zone;

determining, with the WED worn on the head of the user, when the user is leaving the zone; and

displaying, with the WED worn on the head of the user, a three dimensional (3D) virtual image of the zone in response to the WED determining that the user is leaving the zone.

Ex. 1001 ('509 patent) at Claim 9

Limitations 9[b] And 9[c] Do Not Preclude Use Of A Base Station

Institution Decision

Patent Owner's arguments are unavailing as they are based on the assumption that Petitioner's proposed combination eliminates Pedrotti's base station and that limitation 9[b] precludes the use of a base station with the WED. Neither of these assumptions is correct. Nothing in Petitioner's challenge indicates that the proposed combination eliminates the use of Pedrotti's base station. Moreover, nothing in claim 9 precludes the use of a base station in conjunction with the WED to track the user. Claim 9 merely recites a non-transitory computer readable storage medium storing instructions executed as a method "comprising" determining, "with" the WED, when the user is located inside the zone and leaving the zone, but does not expressly preclude other devices from being involved in those determinations.

Institution Decision at 18

Patent Owner Response

WED performs the act of determination. To be clear, Patent Owner does not argue that limitations 9[b] and 9[c] preclude the use of a base station. Patent Owner merely argues that express language of the limitations requires that the determination of whether the user is inside the zone or not be made exclusively with the WED. As explained in §II.A.3, this requires that the processor responsible for making the determination is located in the WED.

POR at 29-30

Pedrotti Teaches That Its Processor May Be Located In The WED

Pedrotti

In other embodiments, the base station may be only a cradle or dock upon which the controller may rest, perhaps with a groove or contour that conforms to the shape of the controller, with the processor and/or other components located elsewhere. Alternatively, some components may be in the base station and some components located elsewhere.

Ex. 1005 (Pedrotti) at 5:64-6:2

There may be a single processor, or multiple processors performing different functions of the functions described herein. As above, a processor may be located in the base station, or in a separate location, or even in the HMD or one of the controllers if desired. One of skill in the art will appreciate how to determine which and how many processors will be appropriate for a specific intended application. Similarly, as explained above, various tracking techniques may be used in addition to electromagnetic tracking, and in some embodiments some of the other components used for tracking, such as an electromagnetic field source or a camera, may be located in the base station, while in other embodiments they may be located elsewhere.

Ex. 1005 (Pedrotti) at 16:20-32

Pedrotti 177

relative to the user's field of vision. A head-mounted magnetic tracking (HMMT) system is used, in which other parts of a user's body are tracked relative to the HMD on the user's head, rather than relative to a base station. This results in less distortion of the magnetic field used for tracking and thus allows for more accurate determination of the position and orientation of a user's body parts relative to the user's field of vision, so that a more accurate avatar may be presented on the HMD to the user.

Ex. 1032 (Pedrotti 177) at 4:26-34

There may be a single processor, or multiple processors performing different functions of the functions described herein. As above, a processor may be located in the HMD or elsewhere on the user's body, or even in a base station if desired. One of skill in the art will appreciate how to determine which and how many processors will be appropriate for a specific intended application. Instructions for performing the methods herein on a processor may be stored on a non-transitory computer-readable storage medium.

Ex. 1032 (Pedrotti 177) at 10:61-11:2

Skilled Artisans Would Have Known And Been Motivated To Place The Processor In The HMD

Dr. Welch, Supp. Decl.

31. As I discussed in my opening declaration, by at least the early 2000s "smart" phones and other mobile devices included sensors that provided pose estimation and tracking that employed inertial sensors, electromagnetic compasses, cameras, and powerful processors. Indeed, the commoditization of mobile devices such as the Apple iPhone in 2007 drove dramatic improvements in the related components (*e.g.*, sensors, displays, and processors) in terms of size, weight, power, performance, and cost. As I also discussed in my opening declaration, these improvements in smart devices and the associated components heralded the development of AR and VR systems that were self-contained within single head-worn units that included processors, wireless networking, motion tracking, graphics rendering, and high-resolution displays. *See* Op. Decl. §VII, *e.g.*, §VII.A and §VII.D. These advances in the basic components, and their widespread use in commercially available self-contained AR and VR systems, would have motivated skilled artisans to incorporate Pedrotti's tracking processor and other components into Pedrotti's HMD (rather than a separate base station).

Ex. 1173 (Welch Supp. Decl.) ¶ 31

Pedrotti Teaches That Its Processor Determines Locations Of The User And PED

Pedrotti

As above the processor is tracking the position and orientation of the user's head from the tracker of the HMD, and possibly tracking the position and orientation of the user's hand if the user is holding a controller with a tracker. Thus, the processor knows where the user's head and hands are located; if the processor has been provided with information about the boundary of the selected area then the processor can also determine when the user's head and/or hand approaches the boundary.

In one embodiment, when the user's head and/or hand approaches to within a preselected distance, for example, one foot (again, either preprogrammed into the processor or user selectable), of the boundary of the selected area the processor generates a warning that the user is close to the boundary so that the user can take action to avoid the boundary and thus potential collision with the physical objects. In some embodiments, the processor can generate this warning by generating instructions to the HMD display to add some virtual element to the virtual world which can be seen by the user.

Ex. 1005 (Pedrotti) at 12:31-50

Pedrotti

FIG. **15** is a flowchart of a method implemented by a processor that might result in the display of a visual warning such as the virtual fence **1114** of FIG. **11**, or other warnings as described above. As in the method of locating objects described above, it is assumed that a user wears a HMD having a display, a processor provides instructions that direct what appears on the display, and the user is holding a handheld controller having a tracker which can be used to track the position and orientation of the handheld controller.

Ex. 1005 (Pedrotti) at 15:4-12

'509 Patent, Limitation 9[d] (Ground 1)

9[pre]	A non-transitory computer readable storage medium storing instructions that one or more electronic devices execute as a method, the method comprising:
9[a]	dividing, with a portable electronic device (PED) held in a hand of a user, an area around the user into a zone that includes sound localization points (SLPs) in empty space from where binaural sound originates to the user;
9[b]	determining, with a wearable electronic device (WED) worn on a head of the user, when the user is located inside the zone;
9[c]	determining, with the WED worn on the head of the user, when the user is leaving the zone; and
9[d]	displaying, with the WED worn on the head of the user, a three dimensional (3D) virtual image of the zone in response to the WED determining that the user is leaving the zone.

Pedrotti Discloses Displaying A Virtual Fence In Response To The WED Determining The User Leaving The Zone

Pedrotti

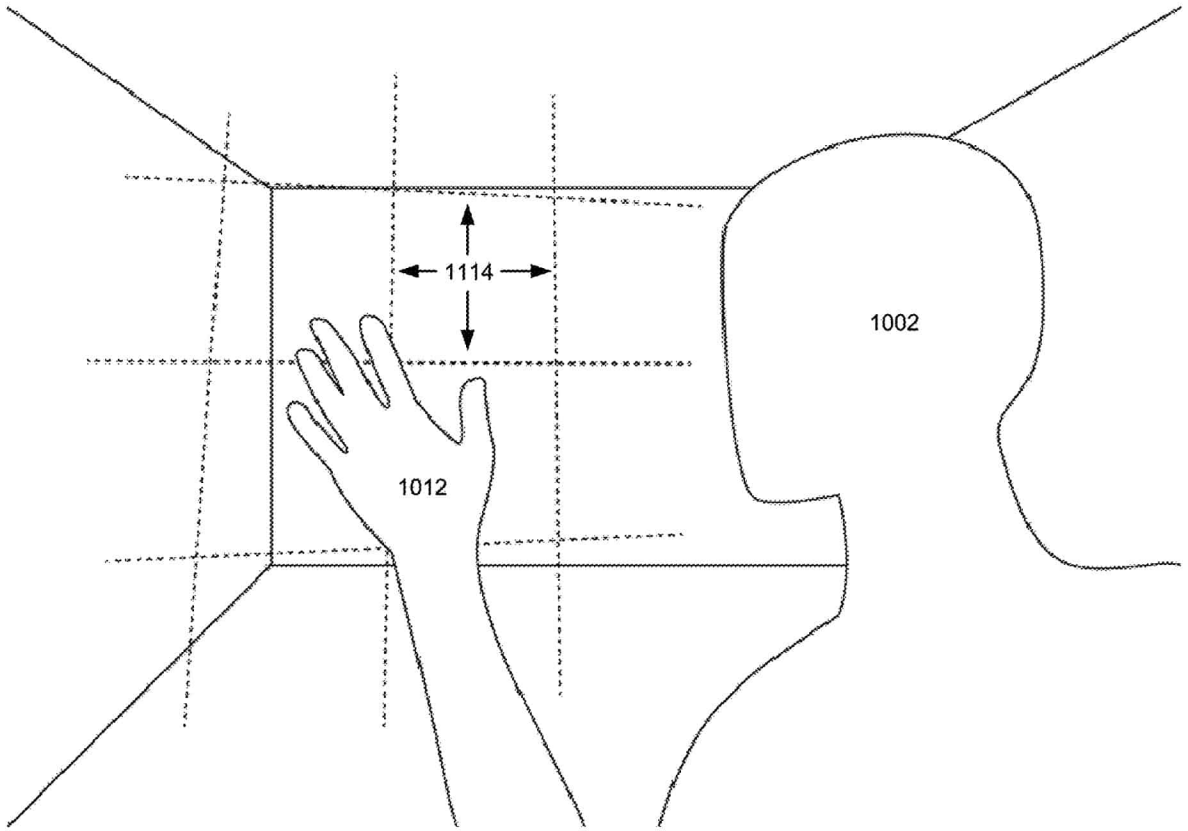


Figure 11

Ex. 1005 (Pedrotti) at Fig. 11

Pedrotti Discloses Displaying A Virtual Fence In Response To The WED Determining The User Leaving The Zone

Pedrotti

FIG. **11** shows one such form of visual warning. In FIG. **11** it is assumed that the user **1002** is holding a controller with a tracker in the hand corresponding to virtual hand **1012**, and that the user **1002** has extended that hand to a point within the preselected distance from the boundary of the selected area. The display in FIG. **11** is similar to that of FIG. **10**, except that since the user **1002** has extended his hand holding the controller, the virtual hand **1012** now extends further in front of the user **1002**.

In addition, since the hand of the user **1002** is within the preselected distance of the boundary of the selected area, the processor generates instructions to the HMD to generate the visual warning. As illustrated in this embodiment, this visual warning is in the form of a grid of lines or a "virtual fence" located at the boundary, as indicated in FIG. **11** by the dashed lines **1114**. The grid can be glowing or colored if

Ex. 1005 (Pedrotti) at 12:51-66

Pedrotti

At step **1504**, the processor determines the position of the handheld controller from the controller tracker. Next, at step **1506**, the processor generates and outputs instructions to the HMD to display on the HMD display a generated virtual world.

Next, at step **1508**, the processor determines from the position of the handheld controller that the handheld controller is within a preselected distance of the boundary. Finally, at step **1510** the processor generates and outputs instructions to the HMD to display on the HMD a visual warning to the user. As above, this visual warning can be in the form of grid lines such as a virtual fence, or some other configuration. In appropriate situations an audible warning can be generated in addition to, or in lieu of, the visual warning.

Ex. 1005 (Pedrotti) at 15:25-39

Virtual Fences, Such As Pedrotti's, Were Well Known

Peck

If the user is very close to the tracker boundary, we **deter** the user from the boundary with a *deterrent*—an object in the environment that people are instructed to stay away from or not to cross. For this implementation, deterrents were 6.5*m* virtual horizontal bars that were aligned with the boundaries of the tracked space. Participants were never able to see all of the deterrent bars because the virtual models occluded much of the deterrent model. See Figure 2 B. The bars fade in as the user nears the boundary of the tracked space and fade out as the user walks away from the boundary. The virtual bars provided participants with a visual cue as to which direction to walk to stay in the real space. No participants complained about the bars.

Ex. 1077 (Peck) at 4

Peck

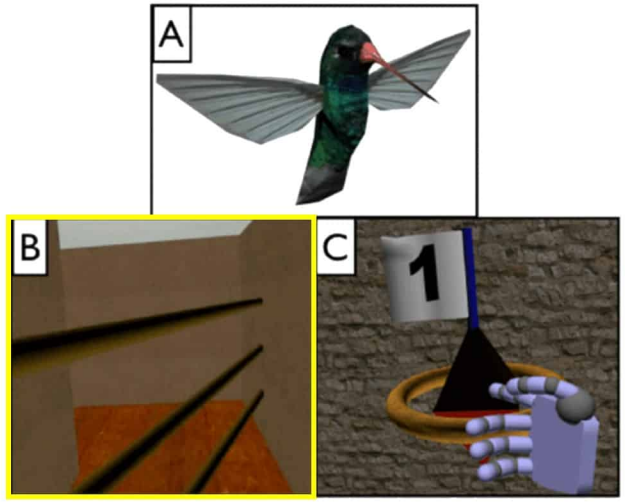


Figure 2.
Screen shots of **A:** the hummingbird distractor, **B:** the horizontal bars used as deterrents, and **C:** the virtual avatar hand selecting a target.

Ex. 1077 (Peck) at Fig. 2

Virtual Fences, Such As Pedrotti's, Were Well Known

The VR Book

18.10 Warning Grids and Fade-Outs

For a user approaching the edge of tracking, a real-world physical object not visually represented in the virtual world (e.g., a wall), or the edge of a safe zone, a **warning grid** (Figure 18.3) or the real world can fade in to provide a cue to the user that he should back off. Whereas such feedback can cause a break-in-presence, it is better than the alternative of the loss of quality tracking that results in a worse break-in-presence and injury.

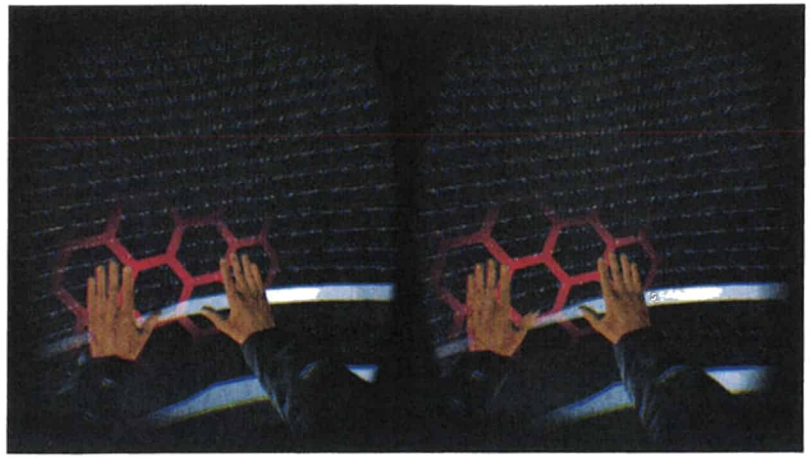


Figure 18.3 A warning grid can be used to inform the user he is nearing the edge of tracked space. (Image courtesy of Sixense)

Ex. 1063 (The VR Book) at 213, Fig. 18.3

Virtual Fences, Such As Pedrotti's, Were Well Known

Sawyer

[0041] Without limitation, sensory feedback can be given in the following ways (including combinations), depending on the requirements of each particular implementation:

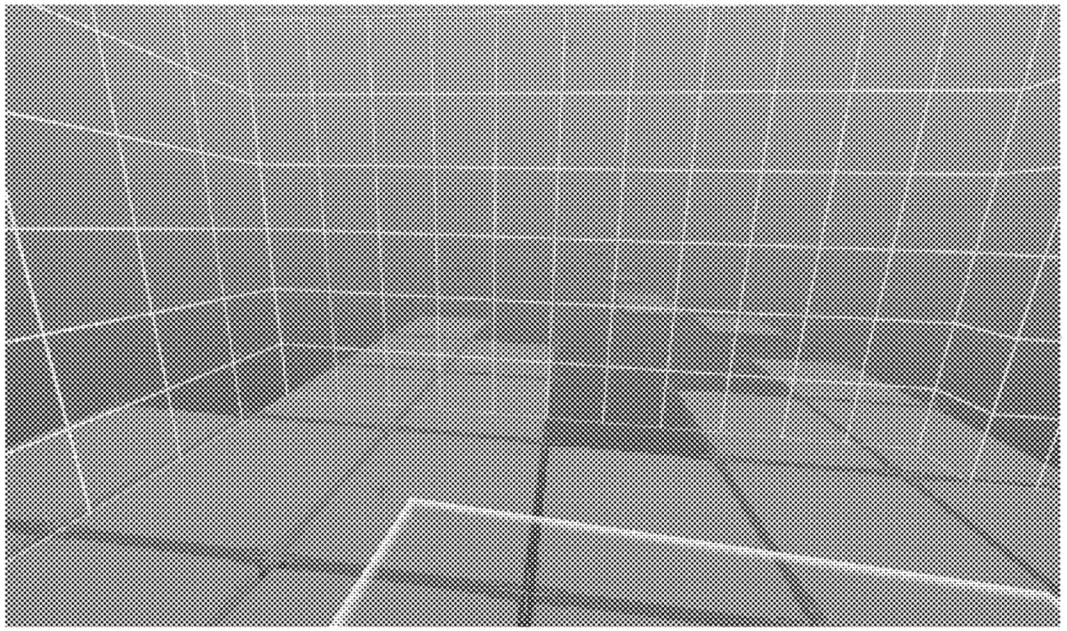
[0042] a warning sound;

[0043] haptic feedback (rumble or actuators included in the HMD or another wearable device such as a game controller held by the user);

[0044] visual warning signs displayed in the HMD;

Ex. 1036 (Sawyer) at [0041]-[0044]

Sawyer



Ex. 1036 (Sawyer) at Fig. 5

'509 Patent, Limitation 10[a] (Ground 1)

10[pre]	The non-transitory computer readable storage medium of claim 9 in which the method further comprises:
10[a]	determining, with the WED, when the PED is pointed at one of the SLPs while the user is located in the zone; and
10[b]	playing the binaural sound that originates from the one of the SLPs in the zone in response to the WED determining that the PED is pointed at the one of the SLPs.

Pedrotti Renders Obvious Determining, With The WED, When The PED Is Pointed At An SLP

Pedrotti

110 will also be known to those of skill in the art. In addition to tracker **108** in HMD **106**, handheld controller **110** may also have a tracker, from which a processor can derive the position and orientation of handheld controller **110** relative to the base station, by any of the tracking techniques described above. Techniques for identifying multiple trackers and distinguishing the position and orientation of each are well known to those of skill in the art.

FIG. **1**B is a representation of the user **102** of FIG. **1**A as the user **102** sees the virtual world, showing the field of view **112** that may be presented to the user by the HMD **106**. As will be known to those of skill in the art, a processor (not shown) generates instructions that cause HMD **106** to present a view to user **102** that is appropriate given the position and orientation of user **102**'s head and any actions taken with controller **110**, so that what is within field of view **112** will change as user **102** moves his or her head and uses controller **110**.

Ex. 1005 (Pedrotti) at 5:29-46

Pedrotti

FIG. **11** shows one such form of visual warning. In FIG. **11** it is assumed that the user **1002** is holding a controller with a tracker in the hand corresponding to virtual hand **1012**, and that the user **1002** has extended that hand to a point within the preselected distance from the boundary of the selected area. The display in FIG. **11** is similar to that of FIG. **10**, except that since the user **1002** has extended his hand holding the controller, the virtual hand **1012** now extends further in front of the user **1002**.

Ex. 1005 (Pedrotti) at 12:51-59

Pedrotti Teaches Pointing At Virtual, Sound-Producing Objects

Pedrotti

FIG. **8** shows one example of what a user might see in a virtual world after the user has extended the user's physical right hand to cause the virtual right hand to extend toward a virtual sword displayed in the virtual world on the HMD, and then entered the appropriate command to pick up the virtual sword **802**. The user's virtual right hand **214** is holding the virtual sword **802**, although of course there is no physical sword and the user's physical right hand is instead still holding the physical controller. The processor can then display movements of the virtual sword **802** based upon movements of the user's physical right hand as determined from motion of the tracker in the physical controller.

Ex. 1005 (Pedrotti) at 9:41-52, Fig. 8

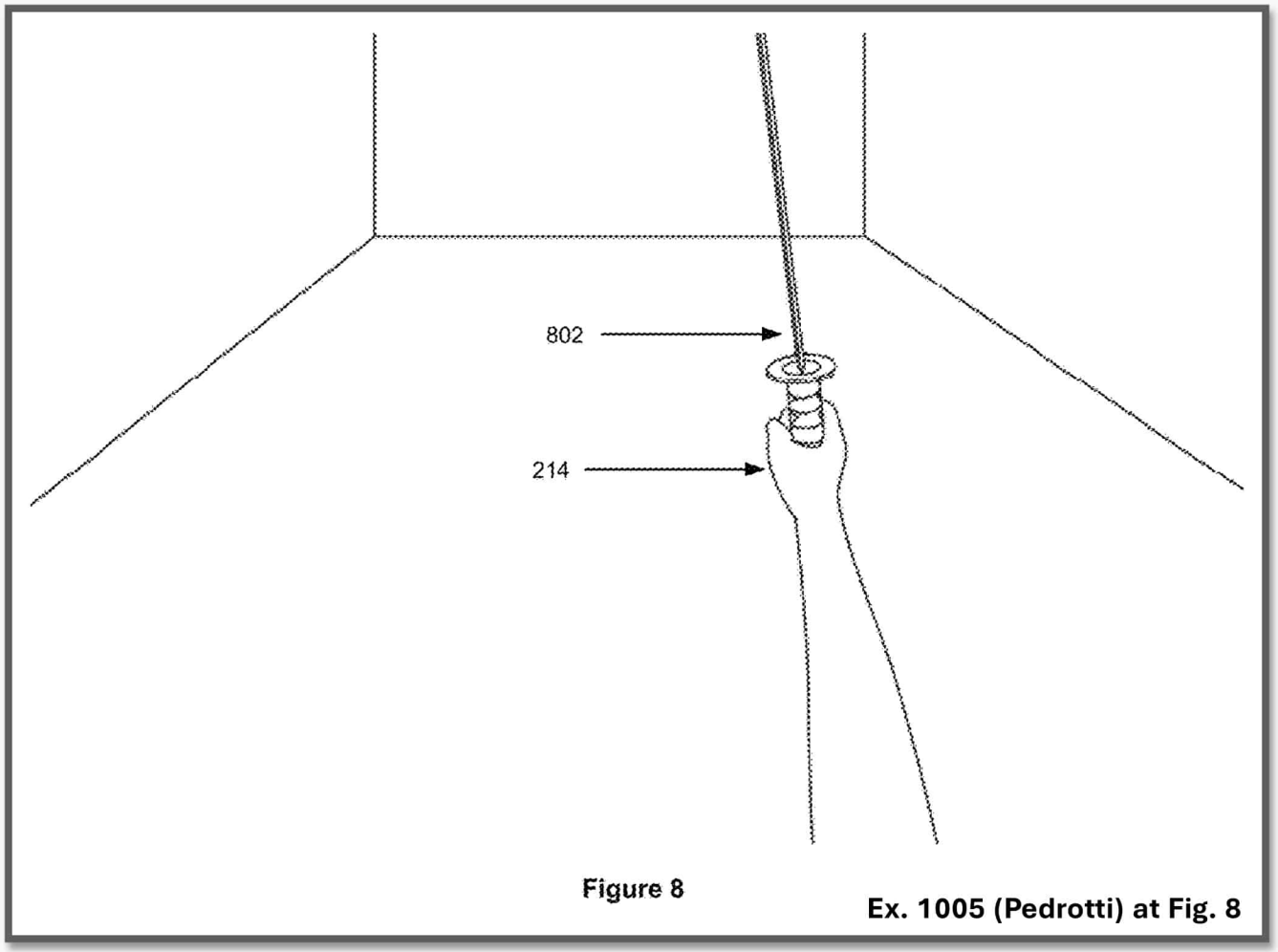


Figure 8

Ex. 1005 (Pedrotti) at Fig. 8

Pedrotti Teaches Pointing At Virtual, Sound-Producing Objects

Patent Owner Sur-Reply

Further, as Patent Owner explained, Pedrotti's virtual objects, such as the "virtual weapon" Petitioner relies on (*see* Reply, at 7), are virtual representations of the controller, ***not an SLP that the controller can point to***, as required by the claim language. *See* POR 7-8 (describing Pedrotti's Figs. 1A and 1B).

POSR at 3

Pedrotti

The processor can continue to generate instructions to the display in the HMD to present the user with changes in the virtual world based upon actions that the user has performed with one or both of the physical controllers. In a conventional video game, for example, a user may use a controller to have a character on a television screen "pick up" a weapon displayed on the screen. Similarly, with the present approach the processor can cause a HMD to display a virtual weapon while the user is in a virtual world. Then, upon the user's extending his or her physical hand(s) in such a way as to cause the corresponding virtual hand(s) to "reach for" the displayed virtual weapon and the user's activating a proper command (e.g., by pressing a button on the controller), the processor can cause the HMD to display the user's virtual hand(s) **214** as "picking up" and holding that virtual weapon.

Ex. 1005 (Pedrotti) at 9:26-40

Jang Renders Obvious Determining When The PED Is Pointed At An SLP

Jang

The control unit **104** may receive an input of a selected virtual reality character from the user to which the virtual reality environment is provided, check sound source information on other characters and other objects existing in the virtual reality spaces already stored in the storage unit **102**, and provides the virtual reality apparatus **110** with sound sources occurring in real time according to the relative locations or situations of the character in the virtual reality environment. In FIG. 1B, the communication unit **106** transfers

Ex. 1006 (Jang) at 7:24-32

Begault Likewise Renders Obvious Determining When The PED Is Pointed At An SLP

Begault

Figure 5.12 shows a hypothetical GUI for arranging these various sound inputs in virtual auditory space in a manner configurable by each individual listener. The basic concept is to represent each form of auditory input iconically on the screen and then allow manipulation of the distance and relative azimuth of each source. The computer interprets the relative location of the icons on the screen as commands to a multiinput, 3-D sound spatialization subsystem.

Ex. 1007 (Begault) at 172

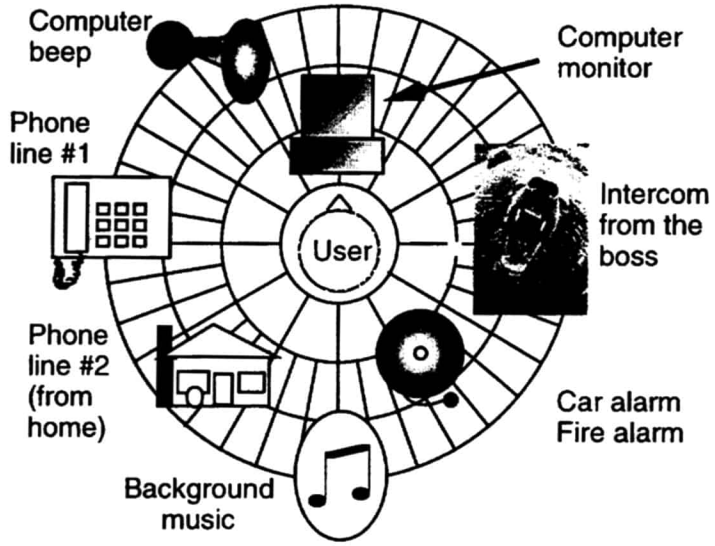


Figure 5.12. Layout for a hypothetical GUI for arranging a set of incoming sounds. By resizing the icons, volume could be adjusted independently of perceived distance. *Graphic assistance by Denise Begault.*

Ex. 1007 (Begault) at Fig. 5.12

Pointing Actions Were Well Known

The VR Book

The Pointing Pattern is one of the most fundamental and often-used patterns for selection. **The Pointing Pattern** extends a ray into the distance and the first object intersected can then be selected via a user-controlled trigger. Pointing is most typically done with the head (e.g., a crosshair in the center of the field of view) or a hand/finger.

Ex. 1063 (The VR Book) at 327

Dr. Welch's Opinions On POSA Knowledge Are Supported By Record Evidence

Patent Owner Sur-Reply

within the "general knowledge" of a PHOSITA. Reply, at 12 n.2. But the Board must reject "a conclusory assertion … about general knowledge in the art ***without evidence on the record***, particularly where it is an important limitation that is not evidently and indisputably within the common knowledge of those skilled in the art." *Arendi S.A.R.L.*, 832 F.3d at 1362-64 (quoting *K/S HIMPP v. Hear–Wear Technologies, LLC*, 751 F.3d 1362, 1365-66 (Fed.Cir.2014)). Petitioner has offered no evidence aside from its conclusory statement in the footnote that the portions of the VR Book and Dr. Begault's testimony that it relies on are in fact within the general knowledge of a PHOSITA.

POSR at 16

Dr. Welch, Decl.

74. It was well known that handheld controllers were used to allow a user to select and manipulate virtual objects, and to interact with a virtual environment and virtual characters. Typical controller gestures included pointing or moving the controller to the virtual object, then pressing a button on the controller to select or grab the object, and moving the controller to manipulate (e.g., move, throw, or aim) the object. U.S. Patent No. 8,419,545 ("Yen") (Ex.1041) at 19:67-11:5 (user waves motion controller to cause avatar to wave virtual object); U.S. Patent No. 9,703,369 ("Mullen") (Ex.1029) at 11:18-26 (handheld controller acts as a pointer using a "virtual laser [that] emanates out of [the] controller."), 9:16-24 (user points motion controller to aim virtual gun at virtual objects), 14:26-15:6 (user presses button on motion controller to grab virtual objects and moves motion controller to move them); U.S. Patent No. 10,162,177 ("Pedrotti") (Ex.1032) at 9:26-40 (user grabs virtual weapon by reaching for it with motion controller and "pressing a button on the controller," and then moves the virtual weapon by moving the controller); Mine, *Exploiting Proprioception in Virtual-Environment Interaction* (1997) ("Mine Exploiting Proprioception 1997") (Ex.1116) at 70-71 (describing "[o]bject selection/manipulation where "[u]sers select and manipulate objects with their dominant hand" and "[t]he default form of manipulation is unconstrained 6DoF manipulation"). These are forms of "direct manipulation," which include "pushing

Ex. 1003 (Welch Decl.) ¶ 74

Case Law Supports Reliance On POSA Knowledge Involving Predictable Application Of Known Technology

B/E Aerospace, Inc. v. C&D Zodiac, Inc.

"First, we affirm the Board's conclusion that the challenged claims would have been obvious because modifying the Admitted Prior Art/Betts combination to include a second recess **was nothing more than the predictable application of known technology**. The prior art **yields a predictable result** …."

B/E Aerospace, Inc. v. C&D Zodiac, Inc., 962 F.3d 1373, 1379-80 (Fed. Cir. 2020) (emphasis added) (internal citations removed)

Koninklijke Philips N.V. v. Google LLC

"[I]t does not follow that we ignore the skilled artisan's knowledge when determining whether it would have been obvious to modify the prior art."

Koninklijke Philips N.V. v. Google LLC, 948 F.3d 1330, 1337-38 (Fed. Cir. 2020) (emphasis added)

Users Obviously Point At Pedrotti's Fences

Pedrotti

FIG. **11** shows one such form of visual warning. In FIG. **11** it is assumed that the user **1002** is holding a controller with a tracker in the hand corresponding to virtual hand **1012**, and that the user **1002** has extended that hand to a point within the preselected distance from the boundary of the selected area. The display in FIG. **11** is similar to that of FIG. **10**, except that since the user **1002** has extended his hand holding the controller, the virtual hand **1012** now extends further in front of the user **1002**.

Ex. 1005 (Pedrotti) at 12:51-59

Pedrotti's Virtual Fence Is, Or Is Obviously, An SLP

Pedrotti

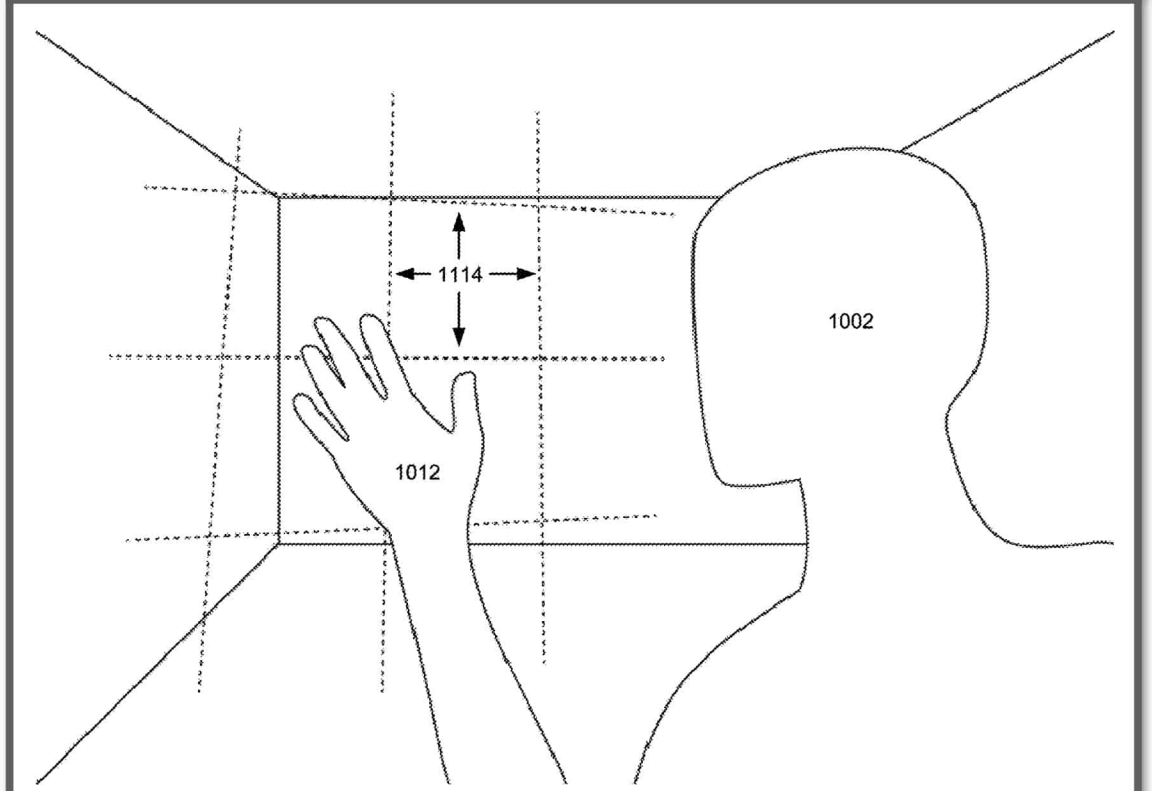


Figure 11

Ex. 1005 (Pedrotti) at Fig. 11

Pedrotti

Also as above, in various embodiments, the processor can generate the visual warning in the form of grid lines or a virtual fence, or in any other desired shape or configuration. In some embodiments, it may again be appropriate to generate an audio warning as well, or instead of, the visual warning.

Ex. 1005 (Pedrotti) at 15:53-58

An "SLP" Can Also Be An Area With Shape And Volume

in the microphones located in the ears of the person. This location where the sound was generated relative to the face of the person represents a SLP (i.e., a point or area where sound is localized). Thereafter, the HPED convolves sound

Ex. 1001 ('509 patent) at 14:58-61

As used herein, a "sound localization point" or "SLP" is a location where a listener localizes sound. A SLP can be internal (such as monaural sound that localizes inside a head of a listener), or a SLP can be external (such as binaural sound that externally localizes to a point or an area that is away from but proximate to the person or away from but not near the person). A SLP can be a single point such as one defined by a single pair of HRTFs or a SLP can be a zone or shape or volume or general area. Further, in some instances,

Ex. 1142 ('737 patent) at 65:23-31

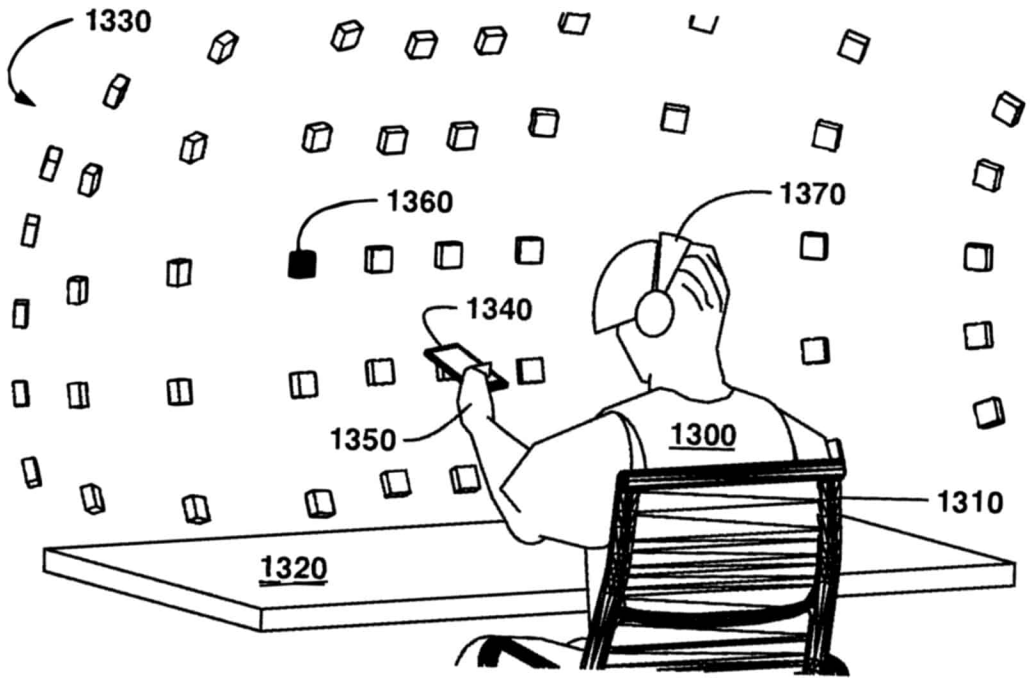


Figure 13

Ex. 1001 ('509 Patent) at Fig. 13

At A Minimum, Pedrotti's Controller Is Obviously Pointing At The Fence

Pedrotti

FIG. **11** shows one such form of visual warning. In FIG. **11** it is assumed that the user **1002** is holding a controller with a tracker in the hand corresponding to virtual hand **1012**, and that the user **1002** has extended that hand to a point within the preselected distance from the boundary of the selected area. The display in FIG. **11** is similar to that of FIG. **10**, except that since the user **1002** has extended his hand holding the controller, the virtual hand **1012** now extends further in front of the user **1002**.

Ex. 1005 (Pedrotti) at 12:51-59

Dr. Welch, Supp. Decl.

Pedrotti discloses that its boundary images, *e.g.*, the fence, are displayed when "the hand of the user," which is holding the controller, comes "within a preselected distance of the boundary" and are highlighted when the user "get[s] still closer." Pedrotti (Ex.1005) at 12:51-13:11, 15:30-32. Skilled artisans would have understood that, in this scenario, the user would be pointing the handheld controller (the PED) at the highlighted boundary image, *e.g.*, the fence. At a minimum, this would have been obvious. Indeed, the handheld controller being pointed at and moving toward the virtual fence is the most likely action to trigger Pedrotti's highlighting, as users typically (and obviously) hold their controllers pointing away from them, and a controller would have (or at a minimum would obviously have) this orientation as a user moved it toward and got still closer to Pedrotti's boundary, triggering the fence and its highlighting (i.e., the claimed highlighting of an SLP).

Ex. 1173 (Welch Supp. Decl.) ¶ 39

Patent Owner Incorrectly Argues That Pedrotti's Fence Is Not "In The Zone"

Patent Owner's Response

i The proposed combination does not teach limitation 1[c].

Limitation 1[c] recites, "highlighting, while the user is located in the zone and with a display of the WED, one of the multiple SLPs in the zone when the PED held in the hand of the user is pointed at the one of the multiple SLPs in the zone." The highlighting occurs for a specific one of the multiple SLPs in the zone when (1) "the user is located in the zone," and (2) "the PED held in the hand of the user is pointed at the" SLP. Petitioner fails to meet its burden to show the cited references disclose even highlighting a SLP much less highlighting a SLP in response to the user pointing at the SLP. Pedrotti is completely silent on highlighting virtual items within the zone and Jang is likewise silent on using a handheld controller to select or emphasize images associated with the sounds from the focus area or the non-focus area.

POR at 5-6

Patent Owner Sur-Reply

In attempt to buttress its weak positions, Petitioner argues that Pedrotti's virtual fence is an SLP. Reply, at 5-6. Pedrotti's virtual fence is not an SLP, however, and more importantly it is not "one of multiple SLPs in the zone." Pedrotti's virtual fence *defines* the zone itself and thus is not *in the zone*, much less be *multiple* SLPs in the zone, as required by the claim limitation. It is inapposite whether the zone itself is highlighted when the user is pointing at the virtual fence with a controller—the claim requires that "one of the multiple SLPs ***in the zone***" be highlighted upon the user pointing at it.

POSR at 4

Virtual Fences, Such As Pedrotti's, Were Well Known

Pedrotti

visual warning. As illustrated in this embodiment, this visual warning is in the form of a grid of lines or a "virtual fence" located at the boundary, as indicated in FIG. **11** by the dashed lines **1114**. The grid can be glowing or colored if desired to be more visible to the user. In other embodiments, other shapes than a grid-shaped virtual fence can be displayed to the user. For example, the developer of a particular application may choose some other design to provide contrast with, or maintain thematic correctness with, the particular virtual world being displayed. In some embodiments, even a uniform translucent glow of a particular color, such as red, may be appropriate to serve as the visual warning. In addition, the brightness of the visual warning may increase as the distance the user is from the boundary decreases to provide further notice that the user is getting still closer to the boundary.

Ex. 1005 (Pedrotti) at 12:66-13:11

Peck

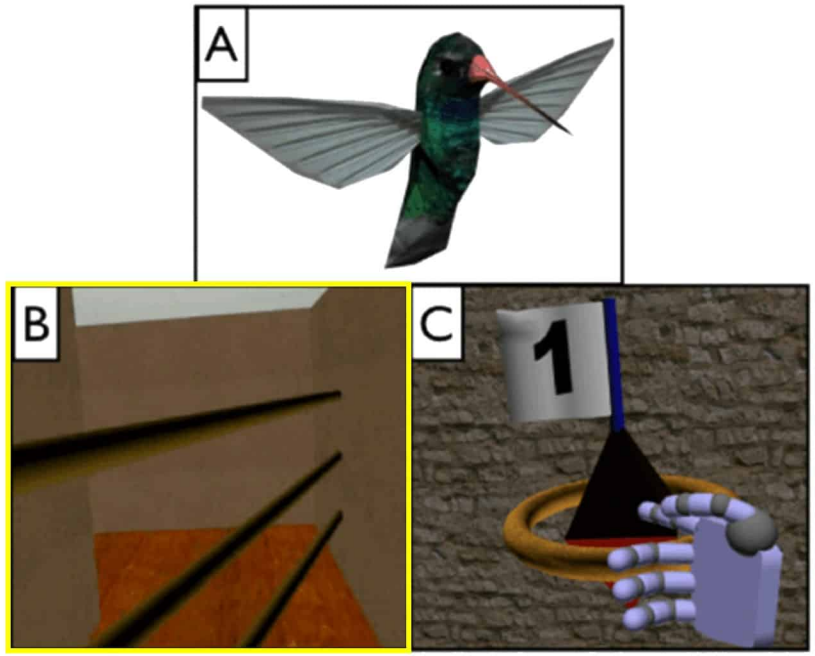


Figure 2.
Screen shots of **A:** the hummingbird distractor, **B:** the horizontal bars used as deterrents, and **C:** the virtual avatar hand selecting a target.

Ex. 1077 (Peck) at Fig. 2

'509 Patent, Limitation 10[b] (Ground 1)

10[pre]	The non-transitory computer readable storage medium of claim 9 in which the method further comprises:
10[a]	determining, with the WED, when the PED is pointed at one of the SLPs while the user is located in the zone; and
10[b]	playing the binaural sound that originates from the one of the SLPs in the zone in response to the WED determining that the PED is pointed at the one of the SLPs.

Pedrotti Discloses That The WED Plays Sound

Pedrotti

Also as above, in various embodiments, the processor can generate the visual warning in the form of grid lines or a virtual fence, or in any other desired shape or configuration. In some embodiments, it may again be appropriate to generate an audio warning as well, or instead of, the visual warning.

Ex. 1005 (Pedrotti) at 15:53-58

Jang Renders Obvious Playing Binaural Sound In Response To The WED Determining The PED Is Pointed At An SLP

Jang

The control unit **104** may receive an input of a selected virtual reality character from the user to which the virtual reality environment is provided, check sound source information on other characters and other objects existing in the virtual reality spaces already stored in the storage unit **102**, and provides the virtual reality apparatus **110** with sound sources occurring in real time according to the relative locations or situations of the character in the virtual reality environment. In FIG. **1B**, the communication unit **106** transfers

Ex. 1006 (Jang) at 7:24-32

Begault Likewise Renders Obvious Playing Binaural Sound In Response To The WED Determining The PED Is Pointed At An SLP

Begault

Figure 5.1. Touch panel pages from the advanced cab cockpit simulator at NASA Ames Research Center, showing how different auditory icons are associated with specific actions. The "latch" icon is distinguished perceptually from the "page through" and "click" icons by use of a louder, more noticeable sound, because it corresponds to an action that changes the operating state of the aircraft.

* * *

HRTF filtering was used to spatialize recordings of the engaged-disengaged button sounds in advance; separate MIDI note-on instructions were used to spatialize the left panel buttons to the left 90 degrees and the right panel to the right 90 degrees for both pilots. Informal observation seemed to suggest that adding auditory feedback in response to tactile actions increased performance and user satisfaction with the virtual controls. It also seemed as though you could feel the switch being engaged in and out, simply by virtue of the proper sound. This experience is a type of **synthesisia**, a cross-perceptual modality sensory substitution.

Ex. 1007 (Begault) at 159-160

Obvious For Pedrotti's Fence To Play Binaural Sound When Pointed At

Pedrotti

Also as above, in various embodiments, the processor can generate the visual warning in the form of grid lines or a virtual fence, or in any other desired shape or configuration. In some embodiments, it may again be appropriate to generate an audio warning as well, or instead of, the visual warning.

Ex. 1005 (Pedrotti) at 15:53-58

Dr. Welch, Supp. Decl.

73. Indeed, I note that, to skilled artisans, coupling the display of Pedrotti's fence with its sound, as Pedrotti teaches, would have been a straightforward implementation of the concept of binding, which was commonly used in the design of virtual environments. Binding refers to conveying "multimodal events as coming from a single entity," and it was known to be "especially important for maximizing intuitive VR interactions." Jerald, THE VR BOOK (Ex.1063) at 72-73. Thus, persons of ordinary skill in the art would have known and been motivated to both highlight Pedrotti's fence and play the fence's audio warning in response to the user pointing the controller at the fence's SLP, as described above.

Ex. 1173 (Welch Supp. Decl.) ¶ 73

Obvious To Apply Begault's Binaural Sound To Pedrotti's Fence

Begault

A common use of representative aural cues in virtual reality is as a means of replacing tactile sensation (haptic feedback) that would normally occur in a real environment. In virtual reality, one can walk through walls and objects; but by activating auditory information in the form of a bumping or crashing sound, the user receives feedback that a particular physical boundary has been violated. But after a while, using a simple crash for all encounters with different types of boundaries becomes increasingly unsatisfying, because it lacks complexity in response to human interaction. While the VIEW system had general application to many sorts of virtual environment scenarios and certainly could make use of these "representational" auditory cues, its use of sound for interaction in a **telepresence** context was vastly more sophisticated.

Ex. 1007 (Begault) at 171

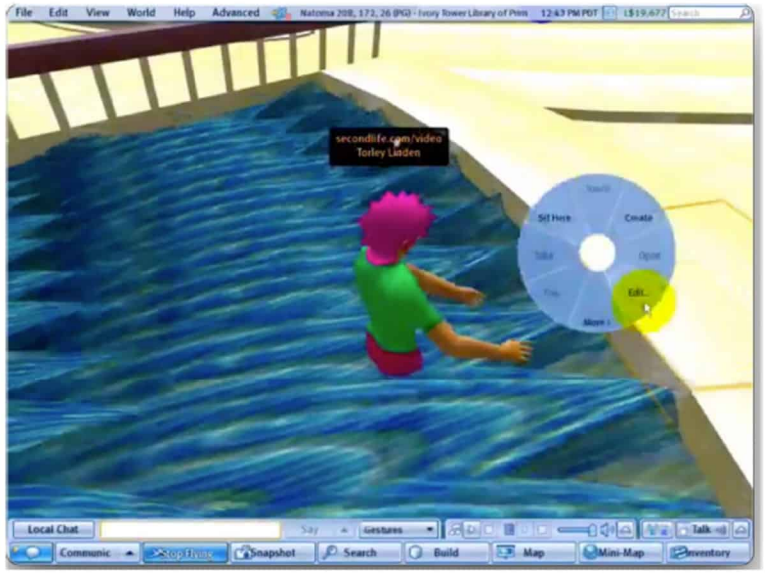
Dr. Welch, Supp. Decl.

73. Indeed, I note that, to skilled artisans, coupling the display of Pedrotti's fence with its sound, as Pedrotti teaches, would have been a straightforward implementation of the concept of binding, which was commonly used in the design of virtual environments. Binding refers to conveying "multimodal events as coming from a single entity," and it was known to be "especially important for maximizing intuitive VR interactions." Jerald, THE VR BOOK (Ex.1063) at 72-73. Thus, persons of ordinary skill in the art would have known and been motivated to both highlight Pedrotti's fence and play the fence's audio warning in response to the user pointing the controller at the fence's SLP, as described above.

Ex. 1173 (Welch Supp. Decl.) ¶ 73

Playing Sounds In Response To Pointing Was Well Known

Turn Off Annoying UI Sounds



Ex. 1166 (Turn Off Annoying UI Sounds) at 1:20-1:24

Client Sounds, Second Life Wiki

Client sounds

From Second Life Wiki

Second Life Wiki > Client sounds

This is a listing of the sounds built into Second Life.

Sound Name	UUID Key	Description	Filename
bell ting	ed124764-705d-d497-167a-182cd9fa2e6c		
click	4c8c3c77-de8d-bde2-b9b8-32635e0fd4a6		
health reduction (female)	219c5d93-6c09-31c5-fb3f-c5fe7495c115		
health reduction (male)	e057c244-5768-1056-c37e-1537454eeb62		
IM session, new incoming	67cc2844-00f3-2b3c-b991-6418d01e1bb7	(2 bells)	
IM start	c825dfbc-9827-7e02-6507-3713d18916c1		
instant message notification	67cc2844-00f3-2b3c-b991-6418d01e1bb7		
invalid operation	4174f859-0d3d-c517-c424-72923dc21f65		
keyboard loop	5e191c7b-8996-9ced-a177-b2ac32bfea06		
money increase	77a018af-098e-c037-51a6-178f05877c6f	(coins)	
money reduction	104974e3-dfda-428b-99ee-b0d4e748d3a3	(cash register bell)	
null keystroke	2ca849ba-2885-4bc3-90ef-d4987a5b983a		
object collision	be582e5d-b123-41a2-a150-454c39e961c8		
object collision	212b6d1e-8d9c-4986-b3aa-f3c6df8d987d	(rubber)	
object collision	d55c7f3c-e1c3-4ddc-9eff-9ef805d9190e	(plastic)	
object collision	2d8c6f51-149e-4e23-8413-93a379b42b67	(flesh)	
object collision	6f00669f-15e0-4793-a63e-c03f62fee43a	(wood splintering?)	
object collision	85cda060-b393-48e6-81c8-2cfdfb275351	(glass break)	
object collision	d1375446-1c4d-470b-9135-30132433b678	(metal clunk)	
object create	3c8fc726-1fd6-862d-fa01-16c5b2568db6	(whoosh)	
object delete	0cb7b00a-4c10-6948-84de-a93c09af2ba9	(shake)	
object rez	f4a0660f-5446-dea2-80b7-6482a082803c		
pie menu appear	8eaed61f-92ff-6485-de83-4dcc938a478e	(ding)	
pie menu slice highlight	d9f73cf8-17b4-6f7a-1565-7951226c305d		
pie menu slice highlight1	f6ba9816-dcaf-f755-7b67-51b31b6233e5	(same as above)	
pie menu slice highlight2	7aff2265-d05b-8b72-63c7-dbf96dc2f21f	(same as above)	
pie menu slice highlight3	09b2184e-8601-44e2-afbb-ce37434b8ba1	(same as above)	
pie menu slice highlight4	bbe4c7fc-7044-b05e-7b89-36924a67593c	(same as above)	
pie menu slice highlight5	d166039b-b4f5-c2ec-4911-c85c727b016c	(same as above)	
pie menu slice highlight6	242af82b-43c2-9a3b-e108-3b0c7e384981	(same as above)	
pie menu slice highlight7	c1f334fb-a5be-8fe7-22b3-29631c21cf0b	(same as above)	

Ex. 1159 (Client Sounds, Second Life Wiki)

Begault

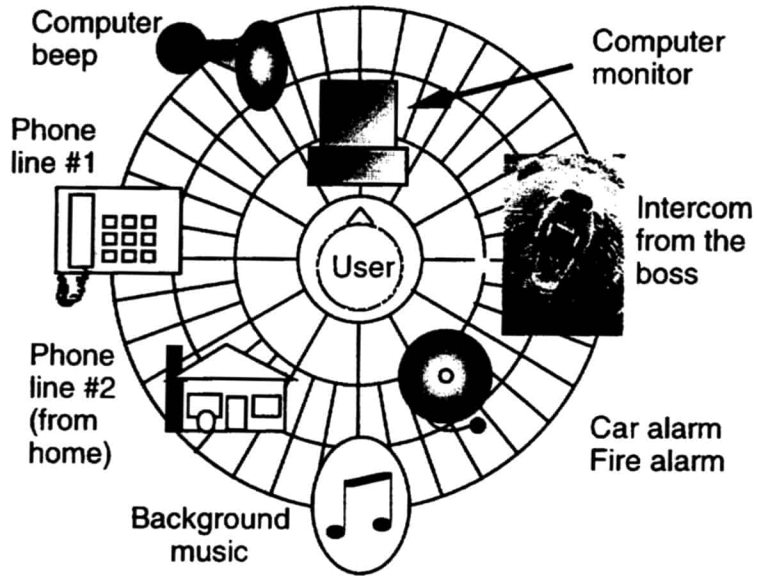


Figure 5.12. Layout for a hypothetical GUI for arranging a set of incoming sounds. By resizing the icons, volume could be adjusted independently of perceived distance. *Graphic assistance by Denise Begault.*

Ex. 1007 (Begault) at Fig. 5.12

Playing Sounds In Response To Pointing Was Well Known

Dr. Welch, Supp. Decl.

77. Additionally, as I explained in my opening declaration, skilled artisans would have known and been motivated to use binaural sound playback, as claimed, to facilitate interactions with, and selection of, the many other types of sound-producing virtual objects disclosed by Pedrotti, Jang, and Begault. Op. Decl. ¶¶ 280-289. For example, taking Pedrotti's disclosed examples of picking up virtual objects (*e.g.*, "gun, sword or other weapon"), it would have been obvious to persons of ordinary skill in the art that pointing at those virtual objects, *e.g.*, to select them to be picked up, would be accompanied by a corresponding sound. For instance, if the user wanted to pick up the virtual gun from an armory, he or she could point at it and, in response, the system would obviously play a corresponding gun loading sound. Or the system could play a sound of a slashing sword if the user pointed at the virtual sword. Or the system could play the buzz of a lightsaber if the user pointed at a lightsaber. Such sound effects were common in video games and computer games, including in VR, prior to February 2016. For example, in the

Ex. 1173 (Welch Supp. Decl.) ¶ 77

'509 Patent, Limitation 11[a] (Ground 1)

11[pre]	The non-transitory computer readable storage medium of claim 9 in which the method further comprises:
11[a]	highlighting, while the user is located in the zone and with a display of the WED, a virtual image at one of the SLPs in the zone when the PED held in the hand of the user is pointed at the one of the multiple SLPs in the zone.

Pedrotti's System Uses Highlighting

Pedrotti

visual warning. As illustrated in this embodiment, this visual warning is in the form of a grid of lines or a "virtual fence" located at the boundary, as indicated in FIG. **11** by the dashed lines **1114**. The grid can be glowing or colored if desired to be more visible to the user. In other embodiments, other shapes than a grid-shaped virtual fence can be displayed to the user. For example, the developer of a particular application may choose some other design to provide contrast with, or maintain thematic correctness with, the particular virtual world being displayed. In some embodiments, even a uniform translucent glow of a particular color, such as red, may be appropriate to serve as the visual warning. In addition, the brightness of the visual warning may increase as the distance the user is from the boundary decreases to provide further notice that the user is getting still closer to the boundary.

Ex. 1005 (Pedrotti) at 12:66-13:11

Patent Owner Ignores Teachings In Pedrotti

Pedrotti

The processor can continue to generate instructions to the display in the HMD to present the user with changes in the virtual world based upon actions that the user has performed with one or both of the physical controllers. In a conventional video game, for example, a user may use a controller to have a character on a television screen "pick up" a weapon displayed on the screen. Similarly, with the present

Ex. 1005 (Pedrotti) at 9:26-32

Patent Owner Sur-Reply

Petitioner must show that Pedrotti teaches highlighting the SLP at which the controller is pointed. Even accepting Petitioner's argument that the virtual fence is an SLP (it is not), Petitioner still has not satisfied its burden on this claim limitation. Indeed, Petitioner admits that Pedrotti does not teach highlighting the virtual fence in response to a user pointing the controller at the virtual fence. Rather, Petitioner argues the virtual fence is highlighted ***by proximity of the user*** within the virtual space, not pointing. *See* Reply, at 6 ("Pedrotti's fence … is highlighted when the user 'get[s] still closer.'") This does not disclose or render obvious limitation 1[c], which requires highlighting in response to pointing, not proximity.

POSR at 4

Pedrotti Renders Obvious Highlighting In Response To Pointing

Pedrotti

FIG. **11** shows one such form of visual warning. In FIG. **11** it is assumed that the user **1002** is holding a controller with a tracker in the hand corresponding to virtual hand **1012**, and that the user **1002** has extended that hand to a point within the preselected distance from the boundary of the selected area. The display in FIG. **11** is similar to that of FIG. **10**, except that since the user **1002** has extended his hand holding the controller, the virtual hand **1012** now extends further in front of the user **1002**.

* * *

ticular virtual world being displayed. In some embodiments, even a uniform translucent glow of a particular color, such as red, may be appropriate to serve as the visual warning. In addition, the brightness of the visual warning may increase as the distance the user is from the boundary decreases to provide further notice that the user is getting still closer to the boundary.

Ex. 1005 (Pedrotti) at 12:51-13:11

Dr. Welch, Supp. Decl.

Pedrotti (Ex.1005) at 12:51-13:11, 15:30-32. Skilled artisans would have understood that, in this scenario, the user would be pointing the handheld controller (the PED) at the highlighted boundary image, *e.g.*, the fence. At a minimum, this would have been obvious. Indeed, the handheld controller being pointed at and moving toward the virtual fence is the most likely action to trigger Pedrotti's highlighting, as users typically (and obviously) hold their controllers pointing away from them, and a controller would have (or at a minimum would obviously have) this orientation as a user moved it toward and got still closer to Pedrotti's boundary, triggering the fence and its highlighting (i.e., the claimed highlighting of an SLP).

Ex. 1173 (Welch Supp. Decl.) ¶ 39

Jang Renders Obvious Selection And Visual Emphasis Of Images Associated With Sound Sources

Jang

the character **200**. The division between the focus area and the non-focus areas in FIG. **2** is only an example and may be modified in various ways according to the characteristics and/or topography of the virtual area at which the character is located in the virtual reality space. For example, while the dividing of sound areas is described with respect to a character **200** and companions **220**, **230**, and **240**, the "companions" need not be players or personages. Rather, each divided focus or non-focus area may contain any number of virtual objects represented by sensory data that may include audio and visual data, for example. Further, at least one of the focus area and the non-focus areas may be divided into multiple areas in the virtual reality space according to a predetermined priority in controlling the volume of the sound or the left-right balance.

Ex. 1006 (Jang) at 8:36-48

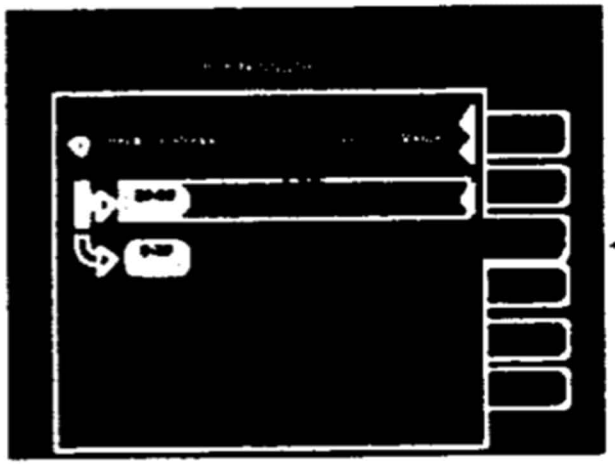
Dr. Welch, Supp. Decl.

52. I further explained in my opening declaration that, in combination with Pedrotti, persons of ordinary skill in the art would have known and been motivated to use Pedrotti's controller to point at and select an image of a pep band in Jang's virtual basketball court associated with the pep band's sound or a conference attendee in Jang's virtual conference room. That sound source (*e.g.*, the pep band or conference attended) would obviously be highlighted when pointed at, consistent with Pedrotti's teachings, before being moved from one location (a first SLP) to a different location in auditory space in the virtual environment (a second SLP). *See* Op. Decl. ¶ 276. Indeed, Jang discloses that its techniques are applicable to games

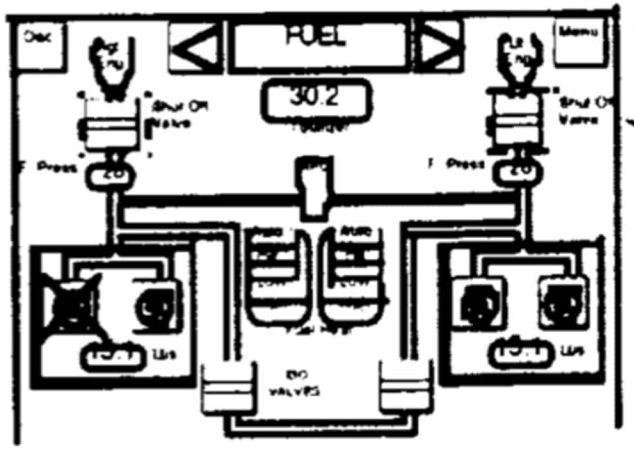
Ex. 1173 (Welch Supp. Decl.) ¶ 52

Begault Likewise Renders Obvious Selection And Visual Emphasis Of Images Associated With Sound Sources

Begault



"Page Through" auditory icon (For selecting menu pages from tabs)



"Click" auditory icon (For selecting items that change orientation within the menu display

"Latch" auditory icon (For actions that correspond to changes in the aircraft electrical, hydraulic, or engine systems)

Ex. 1007 (Begault) at Fig. 5.1

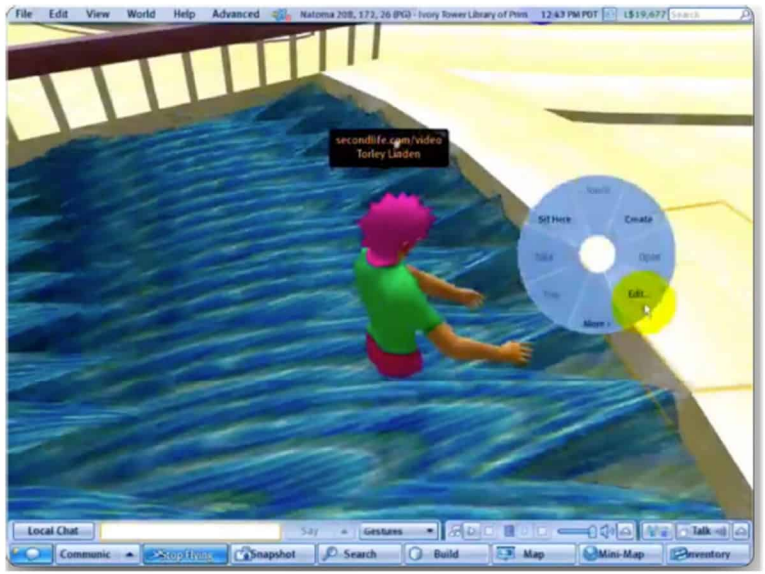
Highlighting Was Well Known

Jang

tance or time to travel from one space to another. An example of such a virtual reality system includes a virtual reality game, "Second Life," developed by Linden Lab of the United States.

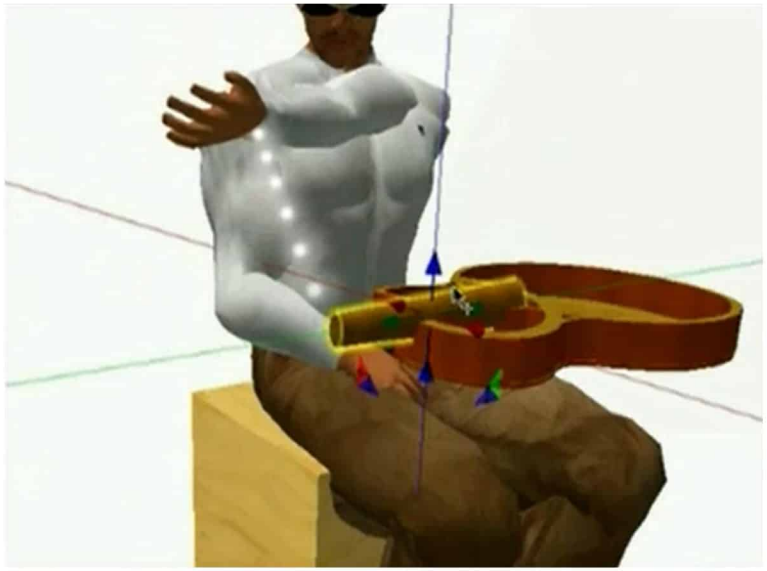
Ex. 1006 (Jang) at 1:65-67

Turn Off Annoying UI Sounds



Ex. 1166 (Turn Off Annoying UI Sounds) at 1:20-1:24

Second Life: The Official Guide



Ex. 1154 (Second Life: The Official Guide, Suzanne's Guitar) at 00:47



Ex. 1154 (Second Life: The Official Guide, Basic Building Demonstration) at 03:30

Highlighting Was Well Known

The VR Book

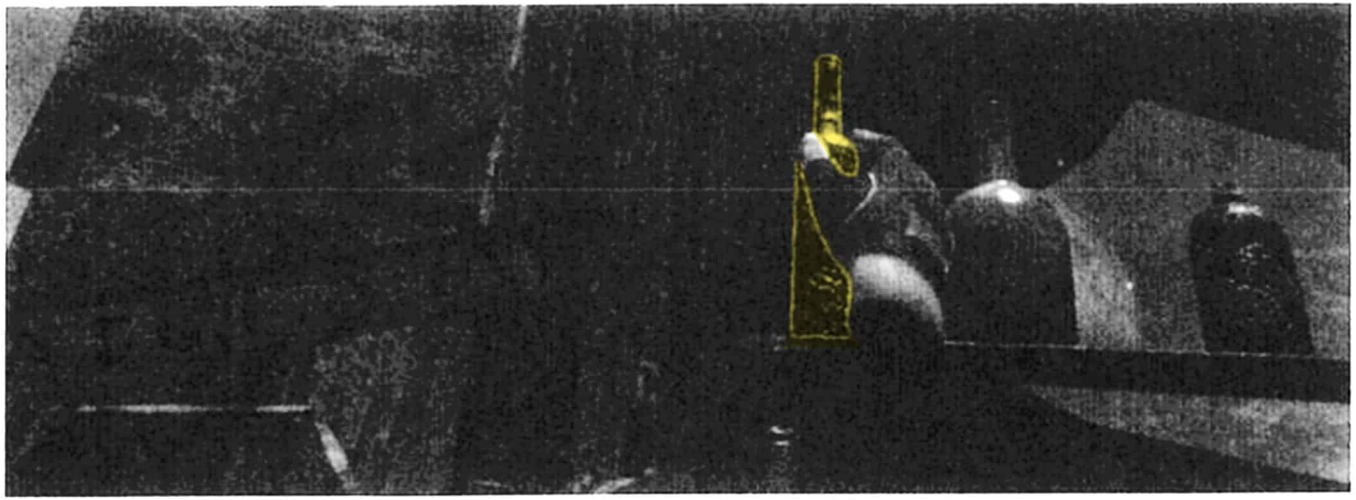


Figure 26.5 **In the game "The Gallery: Six Elements," the bottle is highlighted to show the object can be grabbed.** (Image courtesy of Cloudhead Games)

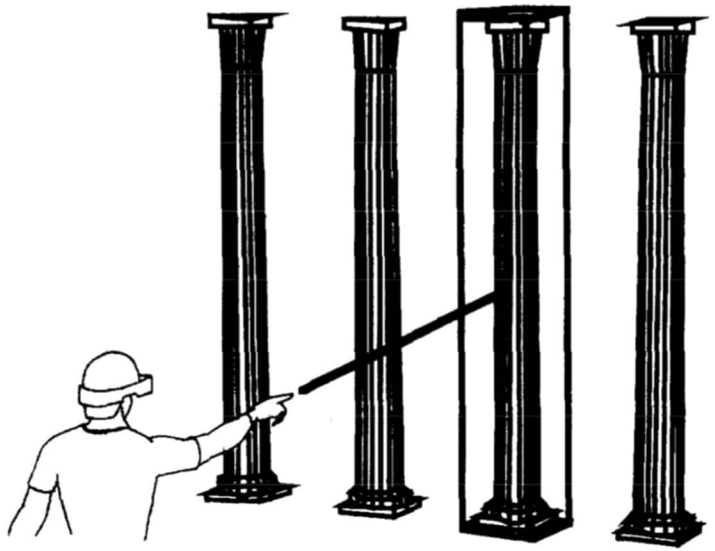
* * *

Highlighting is visually outlining or changing the color of an object. Highlighting is most often used to show the hand has intersected with an object so that it can be selected or picked up. Highlighting is also used to convey that an object is able to be selected or grabbed when the hand is close even though a collision has not yet occurred. Figure 26.5 shows an example of highlighting.

Ex. 1063 (The VR Book) at 305, Fig. 26.5

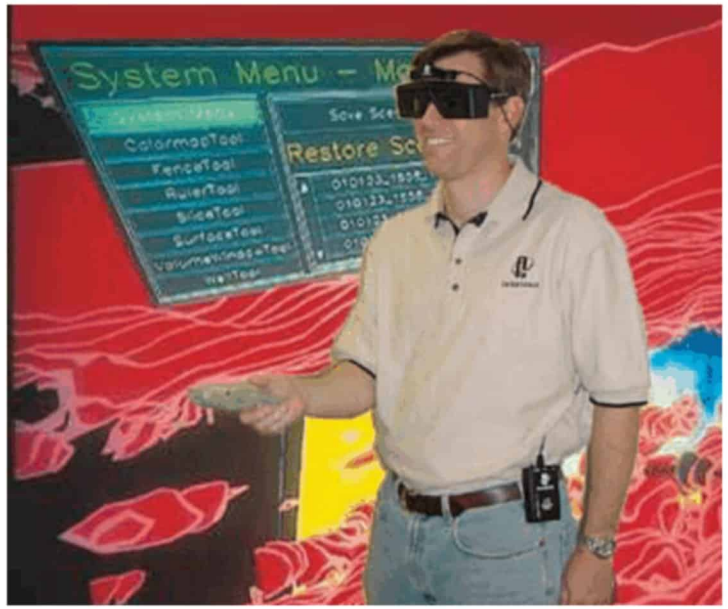
Highlighting Was Well Known

Mine ISAAC



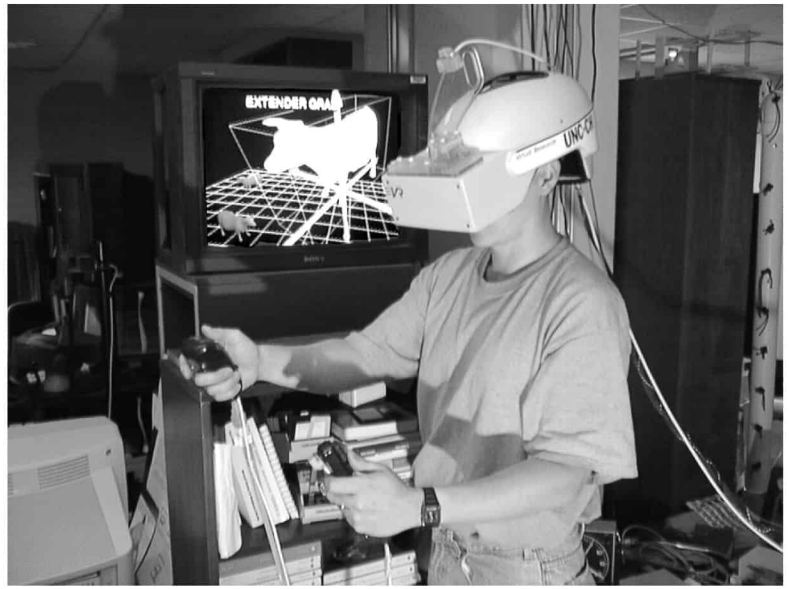
Ex. 1115 (Mine ISAAC) at Fig. 1

No Silver Bullet



Ex. 1135 (Welch) at Fig. 12

Mine Exploiting Proprioception



Ex. 1116 (Mine Exploiting Proprioception 1997) at Fig. 6.1

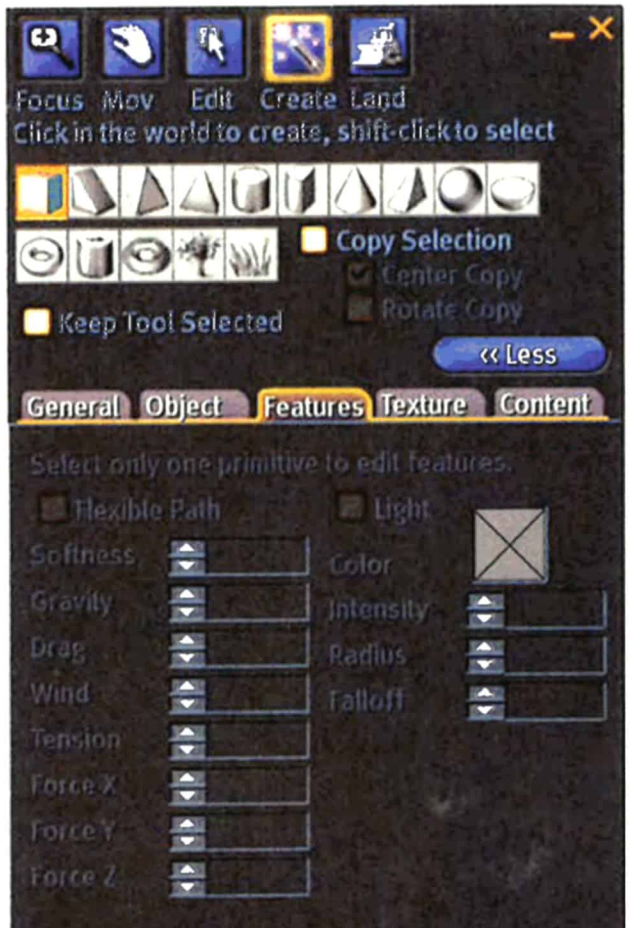
Highlighting Was Well Known

Mullen

Interfaces can be selected from a virtual graphical user interface or virtual hardware in a number of ways. A controller may be utilized as, for example, a pointer such that a virtual laser emanates out of an end of a controller. A virtual laser whose path intersects with a virtual interface may, for example, cause that virtual interface to change its appearance (e.g., appear highlighted). A user may then, for example, press a button to confirm selection of the virtual interface and an associated feature may be executed. Manual controls (e.g., a directional pad) may be utilized to navigate through executable portions of a graphical user interface or virtual object (e.g., virtual hardware). Voice-based and/or thought-based controls may also be utilized.

Ex. 1029 (Mullen) at 11:18-30

Second Life: The Official Guide



Ex. 1151 (Second Life: The Official Guide) at Fig. 7.4

'509 Patent, Limitation 2[a] (Ground 1)

2[pre]	The method of claim 1 further comprising:
2[a]	tracking, with one or more sensors in the WED worn on the head of the user, the PED to determine when the PED moves outside the zone; and
2[b]	displaying, with the WED worn on the head of the user, a three dimensional (3D) virtual image that shows a size and a shape of the zone in response to the WED determining that the PED moved outside the zone

Pedrotti Renders Obvious Tracking Light-Emitting PEDs With Sensors In The WED

Pedrotti

Another such example are light-emitting trackers which can be seen by, and therefore provide position and orientation information to, a camera mounted on the base station or elsewhere. Other forms of trackers, including those incorporating inertial sensors (e.g., accelerometers and/or gyroscopes), can likewise be used in the present approach. As would be understood by one of ordinary skill in the art in light of the teachings herein, essentially any type of tracker (e.g., magnetic, optical, electrical, sonar, radar, ultrasonic, or any combination thereof) which can provide information regarding its position (and, in some cases, orientation, if needed or desired) can be used in the present approach. Such techniques are all contemplated as being within the described system and method, including techniques which can only provide position information, and not orientation, even though the below discussion generally refers to electromagnetic tracking.

Ex. 1005 (Pedrotti) at 5:8-24

Dr. Welch, Decl.

296. Indeed, the use of sensors on HMDs for tracking controllers—including sensors that could and would be used to track light-emitting controllers—was well-known. *See, e.g.*, Ambrus (Ex.1043) at [0075] ("pose and/or movement data may

* * *

including tracking of controllers). Persons of ordinary skill in the art would have further understood and appreciated that tracking a handheld controller using LEDs on a handheld controller and cameras on an HMD as taught by Pedrotti (Ex.1005) (at 5:8-24) would have relatively high accuracy, high resolution, and high speed (with low latency), which is particularly important for handheld controllers as humans can move their wrists relatively fast.

Ex. 1003 (Welch Decl.) ¶ 427

The Processor Performing Tracking Based On Sensors In The WED Can Be In Pedrotti's HMD

Pedrotti

The processor similarly tracks the position and orientation of the HMD tracker, and possibly the position and orientation of one or more trackers in the physical controllers, and generates instructions to the HMD to include in a display of a virtual world a visual warning such as a grid or virtual fence when the user comes within a preselected distance of the boundary, thus providing a warning that the user is about to move out of the selected area.

Ex. 1005 (Pedrotti) at 4:37-44

Pedrotti

There may be a single processor, or multiple processors performing different functions of the functions described herein. As above, a processor may be located in the base station, or in a separate location, or even in the HMD or one of the controllers if desired. One of skill in the art will appreciate how to determine which and how many processors will be appropriate for a specific intended application. Similarly, as explained above, various tracking techniques may be used in addition to electromagnetic tracking, and in some embodiments some of the other components used for tracking, such as an electromagnetic field source or a camera, may be located in the base station, while in other embodiments they may be located elsewhere.

Ex. 1005 (Pedrotti) at 16:20-32

Patent Owner Narrowly Focuses On One Embodiment In Pedrotti

Patent Owner Response

First, Pedrotti is unequivocally clear that the tracking of the controllers is done by the camera or sensor in the base station "or elsewhere,"[2] but certainly ***not the WED***. This is demonstrated in Pedrotti Figures 3-6 and 7:6-8:58.

* * *

[2] The "elsewhere" in Pedrotti always refers to stationary devices other than the base station. In discussing Figure 1A, Pedrotti provides a list of examples that may generate electromagnetic field to be sensed for tracking: "Attached to or incorporated in the HMD 106 is a tracker 108, which can be used to determine the position and orientation of the headset 104, and thus of the head of user 102, by, for example, sensing an electromagnetic field generated from a local base station, video game console or ***other apparatus (not shown)***." Pedrotti, 4:49-54. The HMD is shown in Figure 1A, and thus Pedrotti's reference to "other apparatus" cannot reasonably include the HMD.

POR at 20 n.2

Pedrotti

FIG. **1A** shows a user **102** in the real world wearing a HMD **106**; HMD **106** covers the user's eyes and presents the user with a representation of a virtual world, while preventing the user from seeing the real, or physical, world.

Attached to or incorporated in the HMD **106** is a tracker **108**, which can be used to determine the position and orientation of the headset **104**, and thus of the head of user **102**, by, for example, sensing an electromagnetic field generated from a local base station, video game console or other apparatus (not shown). The tracker **108** provides information about the sensed magnetic field to a processor (also not shown), which derives the position and orientation of the tracker **108**, and thus HMD **106**, relative to a source of the electromagnetic field from such information.

Ex. 1005 (Pedrotti) at 4:45-58

Pedrotti Teaches Placing EM Trackers In Controllers

Pedrotti

FIG. **1**A also shows the user **102** holding a controller **110** which the user may pick up with his or her hand(s), and which allows the user to perform various functions in the virtual world. Various devices suitable for use as controller **110** will also be known to those of skill in the art. In addition to tracker **108** in HMD **106**, handheld controller **110** may also have a tracker, from which a processor can derive the position and orientation of handheld controller **110** relative to the base station, by any of the tracking techniques described above. Techniques for identifying multiple trackers and distinguishing the position and orientation of each are well known to those of skill in the art.

Ex. 1005 (Pedrotti) at 5:25-36

Pedrotti

Such trackers, and the processors which determine the position and orientation of such trackers, are well known to those of skill in the art. One such example, U.S. Pat. No. 4,737,794, teaches a "method and apparatus for determining remote object orientation and position with an electromagnetic coupling." It shows a plurality of radiating antennas located at a source to provide a plurality of electromagnetic fields spanning three dimensional space and defining a source reference coordinate frame, and a plurality of receiving antennas located on an object to be tracked for receiving that field. A processor receives the outputs from the receiving antennas and converts the received components of the transmitted electromagnetic fields into remote object position and orientation relative to the source reference coordinate frame. The antennas may be, for example, dipole antennas, loop antennas, or coil antennas.

Ex. 1005 (Pedrotti) at 4:59-5:7

Claim Language Does Not Preclude Other Devices' Involvement

Patent Owner Response

One, Petitioner admits once again that in Pedrotti, the processor—not the sensors—tracks the controllers: "***Pedrotti's processor***, which may be 'in the HMD' … ***tracks the HMD and controllers*** so it 'knows where the user's head'—i.e., the user—'and hands are located.'" Pet. 18. Two, Petitioner cites 13 paragraphs from Dr. Welch's declaration to assert that "chaperone systems like Pedrotti's were known," (Pet. 19 (citing Ex.1003 ¶¶130-142)), yet fails to explain how this succinct conclusory statement is pertinent to establishing the obviousness of limitation 2[a]—which requires, *inter alia*, a demonstration that the sensors within the WED track the PED.

* * *

do with limitation 2[a]. Nevertheless, Petitioner admits in Section IV.E.3 that "***the processor in Pedrotti's HMD*** tracks 'the position and orientation of one or more trackers in the physical controllers,'"[1] (Pet. 21 (citing Pedrotti 4:37-44)), whereas limitation 2[a] expressly requires that the WED's sensors track the PED.

POR at 16, 18

2. The method of claim **1** further comprising:
tracking, with one or more sensors in the WED worn on the head of the user, the PED to determine when the PED moves outside the zone; and
displaying, with the WED worn on the head of the user, a three dimensional (3D) virtual image that shows a size and a shape of the zone in response to the WED determining that the PED moved outside the zone.

Ex. 1001 ('509 patent) at Claim 2

9. A non-transitory computer readable storage medium storing instructions that one or more electronic devices execute as a method, the method comprising:
dividing, with a portable electronic device (PED) held in a hand of a user, an area around the user into a zone that includes sound localization points (SLPs) in empty space from where binaural sound originates to the user;
determining, with a wearable electronic device (WED) worn on a head of the user, when the user is located inside the zone;
determining, with the WED worn on the head of the user, when the user is leaving the zone; and

Ex. 1001 ('509 patent) at Claim 9

Well Known To Incorporate Sensors And Processor Into WED To Perform Tracking

McCulloch

an executing application (e.g. a game application). The image and depth data of the one or more 3D capture devices **20** may supplement data captured by one or more capture devices **113** on the near-eye, AR display device **2** and other such AR display devices **8** in an environment or location for 3D mapping, gesture recognition, object recognition and other functions as discussed further below.

A capture device **20** may be a depth camera positioned in a user environment. According to an example embodiment, each capture device **20** may be configured with RGB and IR components to capture video with depth information including a depth image that may include depth values via any suitable technique including, for example, time-of-flight, structured light, stereo image, or the like. According to one

Ex. 1008 (McCulloch) at 6:33-46

Well Known To Incorporate Sensors And Processor Into WED To Perform Tracking

Ambrus

[0076] In some examples the HMD device **700** may also include an optical sensor system that utilizes one or more outward facing sensors, such as color camera **712** or depth camera **714** on HMD device **700**, to capture image data. The outward facing sensor(s) may detect movements within its field of view, such as gesture-based inputs or other movements performed by a user or by a person or physical object within the field of view. The outward facing sensor(s) may also capture 2D image information and depth information from the physical environment and physical objects within the environment.

Ex. 1043 (Ambrus) ¶ 76

Well Known To Incorporate Sensors And Processor Into WED To Perform Tracking

The VR Book

more advantages. For example, a bare-hands camera-based system might be used with tracked hand-held controllers (although simultaneous usage can be difficult due to different characteristics, so bare hands might be used until the controller is picked up). Note the table is based upon inherent physical limitations rather than today's

* * *

Hand-held tracked devices typically use inertial, electromagnetic, ultrasonic, or optical (camera) technologies. Each of these technologies has advantages and disadvantages, and hand-held trackers ideally use some hybrid method of integrating multiple technologies together (sensor fusion) to provide both high precision and accuracy.

Ex. 1063 (The VR Book) at 311, 315

No Meaningful Differences Between Limitations 2[a] and 17[e]

'509 Patent

2. The method of claim **1** further comprising:

tracking, with one or more sensors in the WED worn on the head of the user, the PED to determine when the PED moves outside the zone; and

displaying, with the WED worn on the head of the user, a three dimensional (3D) virtual image that shows a size and a shape of the zone in response to the WED determining that the PED moved outside the zone.

Ex. 1001 ('509 patent) at Claim 2

17. An electronic system comprising:

a portable electronic device (PED) held in a hand of a user that divides an area around the user into a three-dimensional (3D) zone that includes sound localization points (SLPs) in empty space from where binaural sound originates to the user; and

a wearable electronic device (WED) that is worn on a head of the user, wirelessly communicates with the PED, includes speakers that play the binaural sound to the user that emanates from the SLPs in empty space, includes one or more sensors that sense when the PED leaves the zone, and includes a display that displays a 3D virtual image of the zone in response to sensing that the PED leaves the zone, wherein the display displays the 3D virtual image of the zone to warn the user that the user is leaving the zone.

Ex. 1001 ('509 patent) at Claim 17

'509 Patent, Limitation 2[b] (Ground 1)

2[pre]	The method of claim 1 further comprising:
2[a]	tracking, with one or more sensors in the WED worn on the head of the user, the PED to determine when the PED moves outside the zone; and
2[b]	displaying, with the WED worn on the head of the user, a three dimensional (3D) virtual image that shows a size and a shape of the zone in response to the WED determining that the PED moved outside the zone

Pedrotti Renders Obvious Displaying A 3D Image Showing A Size And Shape Of The Zone

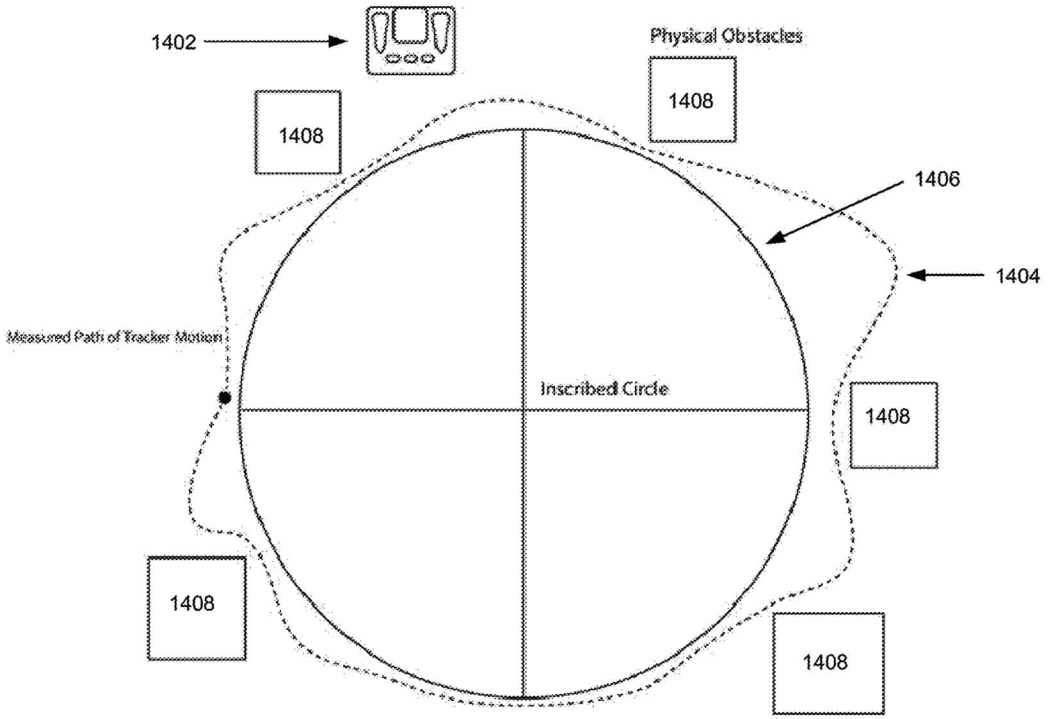


Figure 14

Ex. 1005 (Pedrotti) at Fig. 14

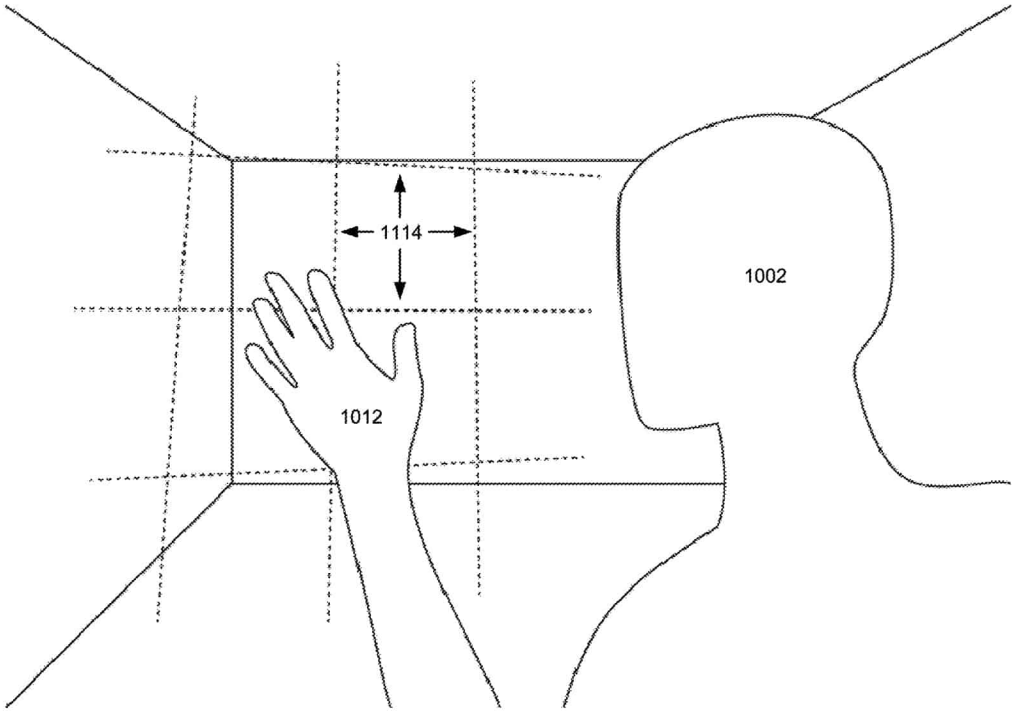


Figure 11

Ex. 1005 (Pedrotti) at Fig. 11

Pedrotti Renders Obvious Displaying In Response To The WED Determining PED Moved Outside The Zone

Pedrotti

If the user's head or hands go beyond the boundary as determined by the trackers, the processor can provide additional messaging or warning, such as text or auditory warnings, or an additional visual warning, that persists until the user returns to the selected area within the boundary. In addition, if the user's head goes beyond the boundary, the processor can cause the HMD to fade to black, and present, for example, only a warning message and/or a beacon or arrows directing the user to move in the direction of the boundary and the selected area.

Ex. 1005 (Pedrotti) at 13:64-14:5