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Facilitating system user interface (UI) interactions in an artificial reality (XR) environment

Abstract

A computer implemented method for facilitating system user interface (UI) interactions in an artificial reality (XR) environment is provided. The method includes rendering the system UI in the XR environment as a 3D virtual element. The method further includes tracking a position of a hand of a user and a pre-defined stable point on the user. The method further includes identifying, based on the tracking, that the hand has grasped a portion of the system UI and, in response, rotating the position of the system UI around the grasped portion of the system UI such that a line, between the stable point and the surface of the system UI, is moved, to be perpendicular or at a predefined angle from perpendicular to the surface of the system UI, as the user moves the system UI via the grasped portion.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

(1) This application is related to U.S. application Ser. No. 18/166,144, titled “Facilitating System User Interface (UI) Interactions in an Artificial Reality (XR) Environment,” filed Feb. 8, 2023; U.S. application Ser. No. 18/166,282, titled “Facilitating User Interface Interactions in an Artificial Reality Environment,” filed Feb. 8, 2023; and to U.S. Application Ser. No. 18/166,258, titled “Intent-Based User Interface Modifications in an Artificial Reality Environment,” filed Feb. 8, 2023 all of which are herein incorporated by reference in their entirety.

TECHNICAL FIELD

(2) The present disclosure is directed to facilitating interactions with a system user interface (UI) in an artificial reality (XR) environment. More specifically, the present disclosure relates to systems and methods for handling or operating the system UI, rendered in the XR environment.

BACKGROUND

(3) Recent advancements in the field of artificial reality (XR) technology have led to development of various artificial reality platforms e.g., for user assistance and entertainment. Artificial reality content may include video, audio, haptic feedback, or some combination thereof, and any of which may be presented in a single channel or in multiple channels. Artificial reality can provide social connection where users may be able to virtually connect with friends in an artificial environment, travel through space and time, play games in a completely new way, etc.

(4) Conventional XR environments enable users to view content in various forms, such as the virtual objects. However, interacting with a virtual object, such as a screen, in the XR environment may be a complex task. For example, the screen may be fixed at a defined distance in the XR environment. Such a fixed screen may be difficult to access or perform fine grained interactions with. Moreover, a size of the screen may be small and the content on the screen may not be clearly

visible by the user. Thus, the experience of using the virtual objects, such as the screen in conventional XR environments may be unsatisfactory and difficult for the users.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. **1** is a block diagram illustrating an overview of devices on which some implementations of the present technology can operate.

(2) FIG. **2**A is a wire diagram illustrating a virtual reality headset which can be used in some implementations of the present technology.

(3) FIG. **2**B is a wire diagram illustrating a mixed reality headset which can be used in some implementations of the present technology.

(4) FIG. **2**C is a wire diagram illustrating controllers which, in some implementations, a user can hold in one or both hands to interact with an artificial reality environment.

(5) FIG. **3** is a block diagram illustrating an overview of an environment in which some implementations of the present technology can operate.

(6) FIG. **4** is a block diagram illustrating components which, in some implementations, can be used in a system employing the disclosed technology.

(7) FIG. **5** is a conceptual diagram illustrating an exemplary environment for user interface (UI) interactions in an artificial reality (XR) environment.

(8) FIG. **6**A and FIG. **6**B are conceptual diagrams illustrating rotation of a system UI in the XR environment.

(9) FIG. **7**A, FIG. **7**B and FIG. **7**C are conceptual diagrams illustrating changing of input modes of the system UI.

(10) FIG. **8** is a flow diagram of a method **800** in some implementations for rotation of the system UI.

(11) FIG. **9**A is a flow diagram of a method used in some implementations for facilitating system user interface (UI) interactions in artificial reality (XR) environment.

(12) FIG. **9**B is a flow diagram of a method used in some implementations for switching the input mode of the system UI and modifying an appearance of the system UI.

(13) FIG. **10** is a conceptual diagram illustrating various implementations and configurations of the system UI.

(14) FIGS. **11**A-**11**D are conceptual diagrams each further illustrating one of the various implementations and configurations of the system UI.

(15) The techniques introduced here may be better understood by referring to the following Detailed Description in conjunction with the accompanying drawings, in which like reference numerals indicate identical or functionally similar elements.

DETAILED DESCRIPTION

(16) Aspects of the present disclosure are directed to facilitating interactions with a system user interface (UI) in an artificial reality (XR) environment. An interaction facilitation system may be provided to facilitate the system UI interactions in the XR environment. A system user interface (UI) may be rendered in the XR environment, in order to facilitate interaction between a user and the system UI, e.g., for providing system controls and settings, showing notifications, providing access to applications built for 2D display systems, providing interfaces to people and social interactions, etc.

(17) The interaction facilitation system may be configured to render the system UI as a 3D virtual element in the XR environment, and track a position of a user in a real world environment. Based on the tracking, the interaction facilitation system may rotate the system UI in the XR environment, similar to a rotation of a device in the real world environment. Furthermore, the interaction

facilitation system may be configured to change an input mode for interaction with the system UI, from a ray casting mode of interaction to a direct touch mode of interaction and vice versa based on a distance of the system UI from the user. The interaction facilitation system may be further configured to modify the system UI having a single screen display to a multi-screen display and vice versa, based on the changed distance and/or input mode.
(18) In an exemplary scenario, a user may utilize the XR environment for different applications, for example, entertainment, healthcare, automotive, education development, social and relationship connections, etc. The system UI may be utilized as a medium to access various applications, such as viewing content, browsing internet, connecting with other users, accessing system controls, and so forth in the XR environment. The interaction facilitating system may receive an input, from the user via an XR device, to open the system UI. The interaction facilitating system can render the system UI in the XR environment based on the received input. Furthermore, the interaction facilitating system can track the position of a hand of the user and a pre-defined stable point on the user. For example, the stable point of the user may be determined based on a point where a base of the user's head meets the user's neck. The tracking may be performed to determine the actual position and/or gestures of the hand of the user in the real world environment.
(19) In an implementation, the user may perform the gesture of moving the hand close to the system UI (e.g., to grab and rotate the system UI). Based on a determination that the tracked position of the user's hand has grasped a portion of the system UI and the user needs to rotate the system UI, the interaction facilitating system may rotate the position of the system UI around the grasped portion of the system UI. Moreover, the system UI, is moved such that a line (which may not be displayed), between the stable point and the surface of the system UI, to be to keep the line either perpendicular or at a predefined angle from perpendicular to the surface of the system UI, e.g., as the user moves or rotates the system UI via the grasped portion in the XR environment. For example, the user can grasp and move the system UI in a vertical direction and also rotate the system UI via the grasped portion of the system UI, while the interaction facilitation system keeps the system UI surface pointed toward the user by maintaining the line as perpendicular to the system UI surface. Thus, the interaction facilitating system moves and/or rotates the system UI such that the surface of the system UI remains towards eyes of the user, when user moves or rotates the system UI in the XR environment.
(20) In another implementation, the interaction facilitating system may further switch input modes of the system UI based on a distance of the user from the system UI. For example, based on a determination that the distance between the user and the system UI is below a first threshold, the interaction facilitating system may change the input mode of interaction from ray casting to a direct touch mode of interaction in which a representation of the hand of the user is rendered in the XR environment. For example, when the distance between the hand of the user and the system UI is below the first threshold (e.g., inside a distance of a determined typical arm length or a determined length of the arm of the current user), the input mode may be changed to the direct touch mode of interaction in which the user can view the representation of the hand interacting with the system UI. Such direct touch mode of interaction gives an impression of directly touching the system UI in the XR environment, similar to touching and accessing a device in the real world environment. Moreover, in such a case, an appearance of the system UI is modified to have a flat shape and may include the single screen display. Moreover, an appearance of a set of UI elements of the system UI is modified to have a three-dimensional shape and a fixed size. Thus, the set of UI elements may appear to partially extend above a plane of the system UI surface, making it easier for the user to understand and interact with controls on the system UI and further provides an enhanced viewing experience to the user.
(21) Furthermore, based on a determination that the distance between the user and the system UI is above a second threshold (which may also be based on a determined length of a typical arm or a determined length of the arm of the current user), the computing system may change the input

mode of interaction from the direct touch to the ray casting mode of interaction, in which a virtual line is rendered under the user's control (e.g., based on the user's hand or controller position) that interacts with the set of UI elements. For example, the when the distance between the hand of the user and the system UI is above the second threshold, the input mode may be changed to the ray casting mode of interaction in which the user can view the virtual line (such as a ray or a ray with a pointer) interacting with the system UI. Such ray casting mode of interaction gives an ability to interact with the system UI from a distance in the XR environment. In such a case, the appearance of the system UI can be modified to have a curved shape and may include the multi-screen display. Moreover, the appearance of the set of UI elements of the system UI can be modified to have a two-dimensional shape and a relative size. Moreover, the first threshold may be closer than the second threshold. Thus, the interaction facilitating system enables switching between the input modes to be a smooth and a glitch free experience for the user.

(22) Embodiments of the disclosed technology may include or be implemented in conjunction with an artificial reality system. Artificial reality or extra reality (XR) is a form of reality that has been adjusted in some manner before presentation to a user, which may include, e.g., virtual reality (VR), augmented reality (AR), mixed reality (MR), hybrid reality, or some combination and/or derivatives thereof. Artificial reality content may include completely generated content or generated content combined with captured content (e.g., real-world photographs). The artificial reality content may include video, audio, haptic feedback, or some combination thereof, any of which may be presented in a single channel or in multiple channels (such as stereo video that produces a three-dimensional effect to the viewer). Additionally, in some embodiments, artificial reality may be associated with applications, products, accessories, services, or some combination thereof, that are, e.g., used to create content in an artificial reality and/or used in (e.g., perform activities in) an artificial reality. The artificial reality system that provides the artificial reality content may be implemented on various platforms, including a head-mounted display (HMD) connected to a host computer system, a standalone HMD, a mobile device or computing system, a “cave” environment or other projection system, or any other hardware platform capable of providing artificial reality content to one or more viewers.

(23) “Virtual reality” or “VR,” as used herein, refers to an immersive experience where a user's visual input is controlled by a computing system. “Augmented reality” or “AR” refers to systems where a user views images of the real world after they have passed through a computing system. For example, a tablet with a camera on the back can capture images of the real world and then display the images on the screen on the opposite side of the tablet from the camera. The tablet can process and adjust or “augment” the images as they pass through the system, such as by adding virtual objects. “Mixed reality” or “MR” refers to systems where light entering a user's eye is partially generated by a computing system and partially composes light reflected off objects in the real world. For example, a MR headset could be shaped as a pair of glasses with a pass-through display, which allows light from the real world to pass through a waveguide that simultaneously emits light from a projector in the MR headset, allowing the MR headset to present virtual objects intermixed with the real objects the user can see. “Artificial reality,” “extra reality,” or “XR,” as used herein, refers to any of VR, AR, MR, or any combination or hybrid thereof.

(24) The term “system user interface (UI),” as used herein, refers to a virtual user interface (UI) that allows users to interact with virtual objects, environments, or information in the physical or virtual space. The system UI may include a set of UI elements or feature elements that may be used to features and controls such as system settings for the artificial reality device, system notifications, XR navigation controls, flat-panel applications (e.g., android or iOS apps, web browser or messaging interfaces, etc.), social media platform interfaces, etc. The system UI may be a migrating UI (for example, similar to an electronic tablet in physical world), such that it can be moved from one position to another position in the XR environment with respect to the user in some cases, while in others it may be world locked or locked to a particular area of the user's field

of view. The system UI may be a 2-dimensional (2D) UI or a 3-dimensional (3D) UI.

(25) Conventional XR systems enable a user to interact in the environments, for example, with virtual objects. However, interacting with virtual object, such as a system user interface (UI) in the XR environment may be a complex task for the users. For example, the user may find it difficult to interact with the system UI in the XR environment, since there may be limited haptic feedback, the system UI may be fixed at an undesirable distance in the XR environment, movement of the system UI may be limited, or providing inputs to UI elements of the system UI may be difficult. Thus, the user experiences, using the conventional systems, of interaction and control of the virtual objects, such as the system UI, are unsatisfactory.

(26) In order to improve the interaction and control of the system UI in the XR environment compared to the conventional systems, the interaction facilitation system of the present disclosure provides an improved interaction model for the system UI. For example, the interaction facilitation system enables tracking of a position of the user, such as a hand, head or an eye level of the user, based on the tracking, determines a stable point that is personalized for each user, and rotates the system UI based on the stable point. Thus, as the user moves system UI in the XR environment a rotation is achieved that facilitates user viewing and interacting with the system UI. Further, for moving or rotating the system UI in the XR environment, the interaction facilitation system identifies a portion of the system UI that is grasped by the user, and rotates the system UI from the grasped portion. Such a rotation provides the user a similar experience as that of rotating or moving a device in the real world environment. By performing rotation of the system UI in such a manner that the surface of the system UI faces towards the user angle of the system UI surface may be comfortably viewed by the user in the XR environment. Moreover, the interaction facilitation system enables switching of the input mode and display modes of the system UI based on a distance of the user from the system UI. The switching between the input modes enables a smooth experience for the user at various distances for different purposes.

(27) Several implementations are discussed below in more detail in reference to the figures. FIG. **1** is a block diagram illustrating an overview of devices on which some implementations of the disclosed technology can operate. The devices can comprise hardware components of a computing system **100** that are configured to facilitate system user interface (UI) interactions in an artificial reality (XR) environment. In various implementations, computing system **100** can include a single computing device **103** or multiple computing devices (e.g., computing device **101**, computing device **102**, and computing device **103**) that communicate over wired or wireless channels to distribute processing and share input data. In some implementations, computing system **100** can include a stand-alone headset capable of providing a computer created or augmented experience for a user without the need for external processing or sensors. In other implementations, computing system **100** can include multiple computing devices such as a headset and a core processing component (such as a console, mobile device, or server system) where some processing operations are performed on the headset and others are offloaded to the core processing component. Example headsets are described below in relation to FIGS. **2**A and **2**B. In some implementations, position and environment data can be gathered only by sensors incorporated in the headset device, while in other implementations one or more of the non-headset computing devices can include sensor components that can track environment or position data.

(28) Computing system **100** can include one or more processor(s) **110** (e.g., central processing units (CPUs), graphical processing units (GPUs), holographic processing units (HPUs), etc.) Processors **110** can be a single processing unit or multiple processing units in a device or distributed across multiple devices (e.g., distributed across two or more of computing devices **101-103**).

(29) Computing system **100** can include one or more input devices **120** that provide input to the processors **110**, notifying them of actions. The actions can be mediated by a hardware controller that interprets the signals received from the input device and communicates the information to the processors **110** using a communication protocol. Each input device **120** can include, for example, a

mouse, a keyboard, a touchscreen, a touchpad, a wearable input device (e.g., a haptics glove, a bracelet, a ring, an earring, a necklace, a watch, etc.), a camera (or other light-based input device, e.g., an infrared sensor), a microphone, or other user input devices.

(30) Processors **110** can be coupled to other hardware devices, for example, with the use of an internal or external bus, such as a PCI bus, SCSI bus, or wireless connection. The processors **110** can communicate with a hardware controller for devices, such as for a display **130**. Display **130** can be used to display text and graphics. In some implementations, display **130** includes the input device as part of the display, such as when the input device is a touchscreen or is equipped with an eye direction monitoring system. In some implementations, the display is separate from the input device. Examples of display devices are: an LCD display screen, an LED display screen, a projected, holographic, or augmented reality display (such as a heads-up display device or a head-mounted device), and so on. Other I/O devices **140** can also be coupled to the processor, such as a network chip or card, video chip or card, audio chip or card, USB, firewire or other external device, camera, printer, speakers, CD-ROM drive, DVD drive, disk drive, etc.

(31) In some implementations, input from the I/O devices **140**, such as cameras, depth sensors, IMU sensor, GPS units, LiDAR or other time-of-flights sensors, etc. can be used by the computing system **100** to identify and map the physical environment of the user while tracking the user's location within that environment. This simultaneous localization and mapping (SLAM) system can generate maps (e.g., topologies, girds, etc.) for an area (which may be a room, building, outdoor space, etc.) and/or obtain maps previously generated by computing system **100** or another computing system that had mapped the area. The SLAM system can track the user within the area based on factors such as GPS data, matching identified objects and structures to mapped objects and structures, monitoring acceleration and other position changes, etc.

(32) Computing system **100** can include a communication device capable of communicating wirelessly or wire-based with other local computing devices or a network node. The communication device can communicate with another device or a server through a network using, for example, TCP/IP protocols. Computing system **100** can utilize the communication device to distribute operations across multiple network devices.

(33) The processors **110** can have access to a memory **150**, which can be contained on one of the computing devices of computing system **100** or can be distributed across of the multiple computing devices of computing system **100** or other external devices. A memory includes one or more hardware devices for volatile or non-volatile storage, and can include both read-only and writable memory. For example, a memory can include one or more of random access memory (RAM), various caches, CPU registers, read-only memory (ROM), and writable non-volatile memory, such as flash memory, hard drives, floppy disks, CDs, DVDs, magnetic storage devices, tape drives, and so forth. A memory is not a propagating signal divorced from underlying hardware; a memory is thus non-transitory. Memory **150** can include program memory **160** that stores programs and software, such as an operating system **162**, an interaction facilitating module **164**, and other application programs **166**. Memory **150** can also include data memory **170** that can include, e.g., the user tracking data, configuration data, settings, user options or preferences, etc., configuration data, settings, user options or preferences, etc., which can be provided to the program memory **160** or any element of the computing system **100**.

(34) The interaction facilitating module **164** may be configured to facilitate interaction between the user and the system UI in the XR environment. To facilitate the interaction between the system UI and the user, the interaction facilitating module **164** may perform various functions such as rendering the system UI in the XR environment, tracking a position of a hand of the user and a pre-defined stable point on the user, and identifying that the hand of the user has grasped a portion of the system UI. Based on the identification, the interaction facilitating module **164** may rotate the position of the system UI around the grasped portion of the system UI. For example, the rotation may be such that a line, between the stable point and the surface of the system UI, is moved, to be

perpendicular or at a predefined angle from perpendicular to the surface of the system UI, as the user moves the system UI via the grasped portion.

(35) Furthermore, the interaction facilitating module **164** may determine a distance between the user and the system UI, based on the tracked position of the user. In response to determination that the distance is below a first threshold, the interaction facilitating module **164** may change an input mode of interaction between the user and the system UI, from a ray casting mode of interaction to a direct touch mode of interaction. The direct touch mode of interaction enables the system UI to be accessed by the user from a close distance, similar to accessing a device by hands in the real world environment. The interaction facilitating module **164** may further modify the appearance of the system UI to have a flat shape, and modify the appearance of one or more of the set of UI elements to have a three-dimensional shape and to be a fixed size.

(36) Moreover, in response to determining that the distance between the user and the system UI is above a second threshold, the interaction facilitating module **164** may change the input mode of interaction between the user and the system UI, from the direct touch mode of interaction to the ray casting mode of interaction. The ray casting mode of interaction enables the system UI to be accessed by the user from a far distance. The interaction facilitating module **164** may further modify the appearance of the system UI to have a curved shape, and modify the appearance of one or more of the set of UI elements to have a two-dimensional shape and to be a relative size.

(37) Some implementations can be operational with numerous other computing system environments or configurations. Examples of computing systems, environments, and/or configurations that may be suitable for use with the technology include, but are not limited to, XR headsets, personal computers, server computers, handheld or laptop devices, cellular telephones, wearable electronics, gaming consoles, tablet devices, multiprocessor systems, microprocessor-based systems, set-top boxes, programmable consumer electronics, network PCs, minicomputers, mainframe computers, distributed computing environments that include any of the above systems or devices, or the like.

(38) FIG. **2**A is a wire diagram of a virtual reality head-mounted display (HMD) **200**, in accordance with some embodiments. The HMD **200** includes a front rigid body **205** and a band **210**. The front rigid body **205** includes one or more electronic display elements of an electronic display **245**, an inertial motion unit (IMU) **215**, one or more position sensors **220**, locators **225**, and one or more compute units **230**. The position sensors **220**, the IMU **215**, and compute units **230** may be internal to the HMD **200** and may not be visible to the user. In various implementations, the IMU **215**, position sensors **220**, and locators **225** can track movement and location of the HMD **200** in the real world and in an artificial reality environment in three degrees of freedom (3DoF) or six degrees of freedom (6DoF). For example, the locators **225** can emit infrared light beams which create light points on real objects around the HMD **200**. As another example, the IMU **215** can include e.g., one or more accelerometers, gyroscopes, magnetometers, other non-camera-based position, force, or orientation sensors, or combinations thereof. One or more cameras (not shown) integrated with the HMD **200** can detect the light points. Compute units **230** in the HMD **200** can use the detected light points to extrapolate position and movement of the HMD **200** as well as to identify the shape and position of the real objects surrounding the HMD **200**.

(39) The electronic display **245** can be integrated with the front rigid body **205** and can provide image light to a user as dictated by the compute units **230**. In various embodiments, the electronic display **245** can be a single electronic display or multiple electronic displays (e.g., a display for each user eye). Examples of the electronic display **245** include: a liquid crystal display (LCD), an organic light-emitting diode (OLED) display, an active-matrix organic light-emitting diode display (AMOLED), a display including one or more quantum dot light-emitting diode (QOLED) sub-pixels, a projector unit (e.g., microLED, LASER, etc.), some other display, or some combination thereof.

(40) In some implementations, the HMD **200** can be coupled to a core processing component such

as a personal computer (PC) (not shown) and/or one or more external sensors (not shown). The external sensors can monitor the HMD **200** (e.g., via light emitted from the HMD **200**) which the PC can use, in combination with output from the IMU **215** and position sensors **220**, to determine the location and movement of the HMD **200**.
(41) FIG. **2**B is a wire diagram of a mixed reality HMD system **250** which includes a mixed reality HMD **252** and a core processing component **254**. The mixed reality HMD **252** and the core processing component **254** can communicate via a wireless connection (e.g., a 60 GHz link) as indicated by link **256**. In other implementations, the mixed reality system **250** includes a headset only, without an external compute device or includes other wired or wireless connections between the mixed reality HMD **252** and the core processing component **254**. The mixed reality HMD **252** includes a pass-through display **258** and a frame **260**. The frame **260** can house various electronic components (not shown) such as light projectors (e.g., LASERs, LEDs, etc.), cameras, eye-tracking sensors, MEMS components, networking components, etc.
(42) The projectors can be coupled to the pass-through display **258**, e.g., via optical elements, to display media to a user. The optical elements can include one or more waveguide assemblies, reflectors, lenses, mirrors, collimators, gratings, etc., for directing light from the projectors to a user's eye. Image data can be transmitted from the core processing component **254** via link **256** to HMD **252**. Controllers in the HMD **252** can convert the image data into light pulses from the projectors, which can be transmitted via the optical elements as output light to the user's eye. The output light can mix with light that passes through the display **258**, allowing the output light to present virtual objects that appear as if they exist in the real world.
(43) Similarly to the HMD **200**, the HMD system **250** can also include motion and position tracking units, cameras, light sources, etc., which allow the HMD system **250** to, e.g., track itself in 3DoF or 6DoF, track portions of the user (e.g., hands, feet, head, or other body parts), map virtual objects to appear as stationary as the HMD **252** moves, and have virtual objects react to gestures and other real-world objects.
(44) FIG. **2**C illustrates controllers **270** (including controller **276**A and **276**B), which, in some implementations, a user can hold in one or both hands to interact with an artificial reality environment presented by the HMD **200** and/or HMD **250**. The controllers **270** can be in communication with the HMDs, either directly or via an external device (e.g., core processing component **254**). The controllers can have their own IMU units, position sensors, and/or can emit further light points. The HMD **200** or **250**, external sensors, or sensors in the controllers can track these controller light points to determine the controller positions and/or orientations (e.g., to track the controllers in 3DoF or 6DoF). The compute units **230** in the HMD **200** or the core processing component **254** can use this tracking, in combination with IMU and position output, to monitor hand positions and motions of the user. The controllers can also include various buttons (e.g., buttons **272**A-F) and/or joysticks (e.g., joysticks **274**A-B), which a user can actuate to provide input and interact with objects.
(45) In various implementations, the HMD **200** or **250** can also include additional subsystems, such as an eye tracking unit, an audio system, various network components, etc., to monitor indications of user interactions and intentions. For example, in some implementations, instead of or in addition to controllers, one or more cameras included in the HMD **200** or **250**, or from external cameras, can monitor the positions and poses of the user's hands to determine gestures and other hand and body motions. As another example, one or more light sources can illuminate either or both of the user's eyes and the HMD **200** or **250** can use eye-facing cameras to capture a reflection of this light to determine eye position (e.g., based on set of reflections around the user's cornea), modeling the user's eye and determining a gaze direction.
(46) FIG. **3** is a block diagram illustrating an overview of an environment **300** in which some implementations of the disclosed technology can operate. Environment **300** can include one or more client computing devices **305**A-D, examples of which can include computing system **100**. In

some implementations, some of the client computing devices (e.g., client computing device **305**B) can be the HMD **200** or the HMD system **250**. Client computing devices **305** can operate in a networked environment using logical connections through network **330** to one or more remote computers, such as a server computing device.
(47) In some implementations, server **310** can be an edge server which receives client requests and coordinates fulfillment of those requests through other servers, such as servers **320**A-C. Server computing devices **310** and **320** can comprise computing systems, such as computing system **100**. Though each server computing device **310** and **320** is displayed logically as a single server, server computing devices can each be a distributed computing environment encompassing multiple computing devices located at the same or at geographically disparate physical locations.
(48) Client computing devices **305** and server computing devices **310** and **320** can each act as a server or client to other server/client device(s). Server **310** can connect to a database **315**. Servers **320**A-C can each connect to a corresponding database **325**A-C. As discussed above, each server **310** or **320** can correspond to a group of servers, and each of these servers can share a database or can have their own database. Though databases **315** and **325** are displayed logically as single units, databases **315** and **325** can each be a distributed computing environment encompassing multiple computing devices, can be located within their corresponding server, or can be located at the same or at geographically disparate physical locations.
(49) Network **330** can be a local area network (LAN), a wide area network (WAN), a mesh network, a hybrid network, or other wired or wireless networks. Network **330** may be the Internet or some other public or private network. Client computing devices **305** can be connected to network **330** through a network interface, such as by wired or wireless communication. While the connections between server **310** and servers **320** are shown as separate connections, these connections can be any kind of local, wide area, wired, or wireless network, including network **330** or a separate public or private network.
(50) FIG. **4** is a block diagram illustrating components **400** which, in some implementations, can be used in a system employing the disclosed technology. Components **400** can be included in one device of computing system **100** or can be distributed across multiple of the devices of computing system **100**. The components **400** include hardware **410**, mediator **420**, and specialized components **430**. As discussed above, a system implementing the disclosed technology can use various hardware including processing units **412**, working memory **414**, input and output devices **416** (e.g., cameras, displays, IMU units, network connections, etc.), and storage memory **418**. In various implementations, storage memory **418** can be one or more of: local devices, interfaces to remote storage devices, or combinations thereof. For example, storage memory **418** can be one or more hard drives or flash drives accessible through a system bus or can be a cloud storage provider (such as in storage **315** or **325**) or other network storage accessible via one or more communications networks. In various implementations, components **400** can be implemented in a client computing device such as client computing devices **305** or on a server computing device, such as server computing device **310** or **320**.
(51) Mediator **420** can include components which mediate resources between hardware **410** and specialized components **430**. For example, mediator **420** can include an operating system, services, drivers, a basic input output system (BIOS), controller circuits, or other hardware or software systems.
(52) Specialized components **430** can include a UI system rendering module **434**, a tracking module **436**, a grasp identification module **438**, an input changing module **440**, an appearance modifying module **442**, and components which can be used for providing user interfaces, transferring data, and controlling the specialized components, such as interfaces **432**. In some implementations, the components **400** can be in a computing system that is distributed across multiple computing devices or can be an interface to a server-based application executing one or more of the specialized components **430**. Although depicted as separate components, the

specialized components **430** may be logical or other nonphysical differentiations of functions and/or may be submodules or code-blocks of one or more applications.

(53) The system UI rendering module **434** may be configured to render the system UI in the XR environment. The system UI may be rendered as a 3D virtual object in the XR environment. The system UI may be initially rendered in the XR environment in such a way that the system UI is at an eye level of the user, where the system UI was when it was last visible, attached to a part of the user (e.g., hand or wrist), etc. Further, the system UI may also be rendered at a distance from the user such that the system UI is easily accessible for the user in the XR environment. Details of the rendering of the system UI in the XR environment are further provided, for example, in FIG. **5**.

(54) The tracking module **436** may be configured to track a position of the hand of the user and a pre-defined stable point on the user. The tracking of the position of the hand may be performed in order to determine the actual position and/or gestures of the hand of the user in a real world environment. For example, the tracking of the position of the hand is performed to determine the grasping of the system UI by the user. The tracking of the pre-defined stable point on the user is performed to adjust a distance and an angle of the system UI with respect to the user. For example, the tracking of the position may be performed based on input data received using one or more sensors (e.g., cameras, time of flight sensors, IMU units, etc.) on an XR device (for example, the HMD **200** or **250**). Further, the tracking module **436** may also receive the input data based on the controllers **270** associated with the XR device. Details of the tracking of the position of the hand of the user, and the pre-defined stable point are further provided, for example, in FIG. **5**.

(55) The grasp identification module **438** may be configured to identify the grasping of the system UI by the user in the XR environment. The grasping of the system UI by the user may be identified by tracking the position of the hand of the user in the real world environment. Based on the tracking, the grasp identification module **438** may determine that the hand of the user is near an edge of the system UI to grasp the system UI. Moreover, the grasp identification module **438** may identify a portion of the system UI grasped by the user in the XR environment. The grasped portion may be further utilized as a point for rotating the position of the system UI in the XR environment. The system UI is rotated around the grasped portion to adjust the position of the system UI corresponding to an eye level of the user. Details of the grasping of the system UI by the user in the XR environment are further provided, for example, in FIG. **6**A.

(56) The input changing module **440** may be configured to change input mode of interaction from ray casting to direct touch mode and vice versa. The input changing module **440** is configured to change input mode of interaction based on a determined distance between the system UI and the user. When the distance between system UI and the user is below a first threshold, the input changing module **440** changes the mode of interaction to a direct touch mode of interaction. When the distance between system UI and the user is above a second threshold, the input changing module **440** changes the mode of interaction to a ray casting mode of interaction. In the direct touch mode of interaction, the user may interact with the three-dimensional (3D) set of UI elements of the system UI. In the ray casting mode of interaction, the user may interact with the two-dimensional (2D) set of UI elements of the system UI. Details of the changing of the input modes of interaction, are further provided, for example, in FIGS. **7**A-**7**C.

(57) The appearance modifying module **442** may be configured to modify the appearance of the system UI and of one or more of the set of UI elements of the system UI. For example, the appearance modifying module **442** is configured to modify a shape of the system UI to be a flat shape in the direct touch mode of interaction. Further, in the direct touch mode of interaction, the appearance modifying module **442** is configured to modify the appearance of the set of UI elements to have the 3D shape and to be a fixed size defined for each of the one or more of the set of UI elements.

(58) The appearance modifying module **442** is further configured to modify the shape of the system UI to a curved shape in the ray casting mode of interaction. In the ray casting mode of interaction,

the user is at a certain distance from the system UI, thus, the curved system UI helps the user to interact more efficiently with the system UI. Furthermore, in the ray casting mode of interaction, the appearance modifying module **442** is configured to modify the appearance the set of UI elements to have the 2D shape and have a relative size defined based on the determined distance of the user from the system UI. For example, when the distance between the user and the system UI is more, the size of the one or more of the set of UI elements may be increased. Details of the modification in the appearance of the system UI and the UI elements, are further provided, for example, in FIGS. **7**A-**7**C, **10**, and **11**A-D.

(59) Those skilled in the art will appreciate that the components illustrated in FIGS. **1-4** described above, and in each of the flow diagrams discussed below, may be altered in a variety of ways. For example, the order of the logic may be rearranged, substeps may be performed in parallel, illustrated logic may be omitted, other logic may be included, etc. In some implementations, one or more of the components described above can execute one or more of the processes described below.

(60) FIG. **5** is a conceptual diagram illustrating an exemplary environment **500** for system UI interactions in the XR environment. The environment **500** may include a real world environment **502**. The real world environment **502** may include a user **504** wearing an XR device **506**. The environment **500** may include an XR environment **502**A (shown by the XR device **506**) that comprises a system UI **508** rendered in the XR environment **502**A. The real world environment **502** and the XR environment **502**A may occupy a same physical space, i.e., user movements in the real world environment **502** can cause corresponding changes, such as to the user's viewpoint, in the XR environment **502**A. In some cases, the XR environment **502**A may be a mixed reality or augmented reality environment, where the user can see an overlay representation of the system UI **508** rendered in conjunctions with the real world environment **502**.

(61) In one implementation, the system UI **508** may be rendered in the XR environment **502**A. The system UI **508** may be 3D virtual element that is rendered in front of the user **504** in the XR environment **502**A. The system UI **508** includes a set of UI elements **510** arranged on a surface of the system UI **508**. The set of the UI elements **510** maybe visual elements that can be seen on the system UI **508**. For example, the set of UI elements **510** may be icons, buttons, menus, text fields, images, videos, 3D meshes, progress bars, and so forth. The set of UI elements **510** enables utilization of the system UI **508** by the users for various purposes for example, browsing a website or accessing an application. The set of UI elements **510** may be of any shape and size.

(62) The system UI **508** may be used to interact with virtual objects, environments, or information on the physical and/or virtual world. More particularly, the system UI **508** may be any UI through which the interaction between users and the XR environment **502**A may occur. The system UI **508** may receive one or more inputs from the user **504** via the XR device **506** and provide an output based on the received input from the user **504**. The system UI **508** may be one of, for example, composite user interface (CUI), and/or multimedia user interface (MUI) and/or the like.

(63) The XR device **506** may be a wearable device that may be used by the user **504** (for example, a person wearing the XR device **502**) to interact with the system UI **508** in the XR environment **502**A. The XR device **506** may be one of physical device, such as including a head-mounted display (HMD) connected to a host computer system, a standalone HMD, a mobile device or computing system, or any other hardware platform capable of providing artificial reality content. For example, the XR device **506** may be the virtual reality head-mounted display (HMD) **200**, as explained, for example, in FIG. **2**A and/or the mixed reality HMD system **250** as explained, for example, in FIG. **2**B. The XR device **506** may have one or more sensors that can track the position of a hand **504**A of the user **504** and/or that can also detect gestures of the hand **504**A of the user **504** in real time. In an example, the hand **504**A of the user **504** may be depicted as a representation of the hand **504**A of the user **504** in the XR environment **502**A. A position of such a representation of the hand **504**A of the user **504** may be updated in the XR environment **502**A based on the

tracking of the position of the hand **504**A of the user **504** in the real world environment **502**. Further, the tracking of the position of the hand **504**A of the user **504** may also be performed using controllers **270** (e.g., hand controller), for example, explained in FIG. **2**C associated with the XR device **506** or a controller that can be a wearable device, which may include self-tracking capabilities similar to those of HMD **200** or **250** or may have a design, emit lighting, or other signals that enable tracking of the controller by HMD **200** or **250**.

(64) The computing system may have one or more sensors that can track the position of a pre-defined stable point **512** on the user **504**. For example, the one or more sensors may be a part of the XR device **506**. The stable point **512** may be a most stable point of a user's head **514**. The stable point **512** on the user **504** may be utilized as a fixed point to adjust a position of the system UI **508** in the XR environment **502**A. In an implementation, the pre-defined stable point **512** on the user **504** may be a point where the base of the user's head **514** meets the user's neck. The point where the base of the user's head **514** meets the user's neck may be selected as the stable point **512** as when the user's head **514** moves, a top end of the neck may remain stationary. Thus, the stable point **512** may be taken as a reference point to arrange the position of the system UI **508** in the XR environment **502**A.

(65) In some implementations, the pre-defined stable point **512** on the user **504** may be a point offset from where the base of the user's head meets the user's neck. For example, the offset can be a certain space (such as three inches) from the base of the user's neck toward the user's eyes. The offset can further be based on a threshold height from an eye level of the user **504**. For example, the pre-defined stable point **512** may be at an offset of 10 centimeter (cm) towards eyes of the user **512**.

(66) In some implementations, the pre-defined stable point **512** may be a point offset from a defined body point on the user **512**. For example, the defined body point may also be a point different from the point where the base of the user's head **514** meets the user's neck. For example, the defined body point may be on shoulder, head, neck, at the eyes, the center of the forehead, or on any other body part of the user **504**. The direction and amount of the offset may be based on a determination of a relative position of the system UI **508** with respect to an eye level of the user **504**. The direction of the offset may be such that the surface of the system UI remains towards the eye level of the user **504**. For example, if the relative position of the system UI **508** is lower than the eye level of the user **504**, the amount of offset may be more. In an exemplary scenario, the position of the system UI **508** is less than a threshold height (e.g., 15 cm) from the eye level of the user **504**, the amount of offset may be 5 cm below the pre-defined stable point **508** for the user **504**. In this manner, the pre-defined stable point **512** may be customized for different users, such that the stable point **512** is unique to each user, for a comfortable and user friendly interaction with the system UI **508**.

(67) FIG. **6**A and FIG. **6**B are conceptual diagrams illustrating rotation of the system UI **508** in the XR environment **502**A. FIG. **6**A depicts a diagram **600**A for illustrating grasping of the system UI **508** by the user **504**. The diagram **600**A includes the XR environment **502**A. The XR environment **502**A includes the system UI **508** and a representation **602** of the hand **504**A of the user **504**.

(68) The computing system may be configured to track the position of the hand **504**A of the user **504** and the stable point **512**. The tracking may be performed, for example, by use of the one or more sensors of the XR device **506** or the controllers **270** associated with the XR device **506**. For example, a distance between an edge of the system UI **508** and the position of the hand **504**A of the user **504** may be tracked. Moreover, a gesture of grasping the edge of the system UI **508** may be tracked. The distance and the gesture may be tracked to determine an intention of the user **504** to grasp the system UI **508**.

(69) In an exemplary scenario, the user **504** moves the hand **504**A (depicted as the representation **602** in the XR environment **502**A) close to the edge of the system UI **508**. The user **504** further performs the gesture of grasping the edge of the system UI **508** by bringing a thumb and one or

more fingers of the hand **504**A together. The computing system tracks the gesture of grasping the system UI **508**.

(70) Based on the tracking of the position of the hand **504**A of the user **504** (such as the gesture and the distance of the hand), the computing system identifies, that the hand **504**A (depicted as the representation **602** in the XR environment **502**A) has grasped a portion **604** of the system UI **508**. After identifying that the hand **504**A has grasped the portion **604** of the system UI **508**, the computing system rotates the position of the system UI **508** around the grasped portion **604** of the system UI **508**. Such a rotation enables restriction of undesirable movement of the system UI **508** in the XR environment **502**A. For example, the rotation around the grasped portion **604** restricts flexible bending movement of the system UI **508**.

(71) Furthermore, the computing system rotates the position of the system UI **508**, such that a line (e.g., line **606** of FIG. **6**), between the pre-defined stable point **512** and the surface of the system UI **508**, is moved, to be perpendicular or at a predefined angle from perpendicular to the surface of the system UI **508**, as the user **504** moves the system UI **508** via the grasped portion **604**. The rotation of the system UI **508** with respect to the line and the stable point **512** is shown in FIG. **6**B.

(72) FIG. **6**B depicts a diagram **600**B for illustrating rotation of the system UI **508** based on the stable point **512** and the grasped portion **604** of the system UI **508**. The diagram **600**B may include the real world environment **502** that may include the user **504** wearing the XR device **506**. The real world environment **502** depicts an overlay representation **508**A of the system UI **508**. The overlay representation **508**A illustrates how the position of the system UI **508** exists relative to the real-world environment **502**. In some cases, the XR environment **502**A may be a mixed reality or augmented reality environment, where the user **504** can see the overlay representation **508**A of the system UI **508** rendered in conjunctions with the real world environment **502**. For example, the user **504** may be able to view the overlay representation **508**A of the system UI **508** rendered in the XR environment **502**A via the XR device **506** while the user **504** can see the real world environment **502**. In other cases, the XR environment **502**A can be a virtual environment where what the user **504** sees is completely computer generated. Thus, in these cases, the overlay representation **508**A of the system UI **508** can be not visible in conjunction with the real world environment **502**, but instead is rendered into the virtual space in which the user **504** is moving while also moving in the real world environment **502**.

(73) A conceptual line **606** is shown between the stable point **512** and the surface of the system UI **508**. For example, the line **606** is a virtual line that is invisible to the user **504**. The line **606** is used to depict the rotation of the system UI **508** with respect to the stable point **512** of the user **504**. As the user **504** moves the system UI **508** via the grasped portion **604** of the system UI **508**, the computing system rotates the position of the system UI **508**. The rotation is such that the line **606** is moved, to be perpendicular or at a predefined angle (discussed below) from perpendicular to the surface of the system UI **508**.

(74) In an exemplary scenario, the user **504** may move the head **514** in the real world environment **502** to view and use the system UI **508**. However, the stable point **512** of the user **504** may remain at a same position as the neck of the user **504** may be unmoved as the head **514** is moved. Thus, the position of the system UI **508** may remain same in the XR environment **502**A, even when the head **514** of the user **504** is moved, thereby providing a hassle-free and comfortable viewing experience to the user **504**. Moreover, when the user **504** moves the system UI **508** in the XR environment **502**A, the system UI **508** is moved such the line **606** between the stable point **512** and the surface of the system UI **508** is perpendicular or at a predefined angle from perpendicular to the surface of the system UI **508**. Thus, when the system UI **508** is moved towards or away from the user **504**, up and down in the XR environment **502**A, or tilted in any direction in the in the XR environment **502**A, the surface of the system UI **508** is towards the head of the user **504**.

(75) In some implementations, the predefined angle from the perpendicular can be a rotation amount toward the user's eyes, e.g., up to five degrees rotation off perpendicular to angle the

system UI surface more toward the user's eyes. In some implementations, the predefined angle can be based on a height of the system UI **508**. Thus, the computing system can rotate the position of the system UI **508** such that the line **606** is moved to be at a predefined angle from the perpendicular to the surface of the system UI **508**, where the predefined angle can be selected based on the determination that the position of the system UI **508** is less than an offset **608** from the threshold height of the user's eyes. The threshold height offset **608**, in FIG. **6**B, is relative to an eye level **610** of the user **504**, but can be set at other characteristics such as the height of the user's shoulder, sternum midpoint, hip height, specified distance above the ground, a relative offset from one of these determined heights, etc. For example, the threshold height offset **608** may be measured from the eye level **610** of the user **504** towards a ground level. The predefined angle can be relative to this height, e.g., a linear or exponential relationship can be defined that provides how much the surface of the system UI **508** should be turned toward the user's eyes given the offset of the system UI **508** from the height **610**. In some cases, the function that defines the linear or exponential can be capped to provide a predefined angle that is no greater than a maximum such as ten degrees.

(76) FIG. **7**A, FIG. **7**B and FIG. **7**C are conceptual diagrams illustrating changing of the input modes of the system UI **508** based on the distance between the user **504** and the system UI **508**. FIG. **7**A includes a diagram **700**A that depicts a direct touch mode of interaction. The diagram **700**A includes the XR environment **502**A. The XR environment **502**A includes the system UI **508** and the representation **602** of the hand **504**A of the user **504**.

(77) The computing system may be configured to track the position of the user **512**. Based on the tracking, the computing system determines the distance between the user **504** and the system UI **508**. In an implementation, the distance between the user **504** and the system UI **508** is determined based on at least the distance between the hand **504**A of the user **504** and the surface of the system UI **508**. The distance between the hand **504**A of the user **504** and the surface of the system UI **508** is depicted as the distance between the representation **602** of the hand **504**A of the user **504** in the XR environment **502**A. For example, the distance is determined by calculating the distance between a portion closest to the system UI **508** and the surface of the system UI **508**. In an example, the distance is determined between a tip of an index finger of the hand **504**A of the user **504** and the surface of the system UI **508**.

(78) Furthermore, in response to determining that the distance is below a first threshold **702**, the computing system may change an input mode from a ray casting mode of interaction to a direct touch mode of interaction. The first threshold **702** may be a distance from the surface of the system UI **508** towards the user **504**. Thus, when the hand **504**A of the user **504** reaches the first threshold **702**, the input mode changes to the direct touch mode of interaction such that the user **504** may directly interact with the system UI **508**. Such direct touch mode of interaction provides the user **504** an experience of directly providing inputs to the system UI **508** via the hand **504**A, similar to providing inputs on a device with hand **504**A in the real world environment **502**. Details of interaction with the system UI **508** using the direct touch mode of interaction are provided in FIG. **7**B.

(79) FIG. **7**B includes a diagram **700**B that depicts the interaction with the system UI **508** using the direct touch mode of interaction. The diagram **700**B includes the XR environment **502**A. The XR environment **502**A includes the system UI **508** and the representation **602** of the hand **504**A of the user **504**. The system UI **508** further includes the set of UI elements **510**. The set of UI elements **510** includes a UI element **704**.

(80) In the direct touch mode of interaction, the representation **602** of the hand **504**A of the user **504** tracks the real-world location of the hand **504**A of the user **504**, and interacts with UI elements, such as the UI element **704** of the set of UI elements **510**. For example, when the hand **504**A of the user **504** moves and touches the UI element **704**, the computing system tracks the hand **504**A, and the representation **602** of the hand **504**A of the user **504** is shown touched to the UI element **704**. In an example, the contact of the hand **504**A of the user **504** and the UI element **704** may enable

selection of the UI element **704** of the set of UI elements **510**.
(81) Further, the computing system may modify an appearance of the system UI **508** to have a flat shape, in the direct touch mode of interaction. For example, the edge of the system UI **508** may be flat such that a display of the system UI **508** appears to be flat. Thus, in the direct touch mode of interaction, the computing system provides the user **504** an experience of interacting with the system UI **508** as a touch-screen device, similar to an electronic tablet in the real world environment **502**.
(82) In an implementation, the system UI **508** having the flat shape comprises a single screen display. As the system UI **508** is close to the user **504** (and may be held by another hand of the user) in the direct touch mode of interaction, viewing the single screen display may provide a comfortable viewing experience to the user **504**.
(83) Furthermore, the computing system may modify an appearance of the one or more of the set of UI elements **510** to have a three-dimensional (3D) shape and to be a fixed size defined for each of the one or more of the set of UI elements **510**. The 3D shape may enable the set of UI elements **510** to be at a height from the surface of the system UI **508**. The set of UI elements **510** may be shown in the 3D shape such that the user **504** may easily identify which UI element to target. Moreover, the size of the set of UI elements **510** may be fixed, and in some embodiments, the size of the selected UI element may be increased. For example, the size of the UI element **704** may increase when selected.
(84) The computing system may be further configured to switch the input mode from the direct touch mode of interaction to the ray casting mode of interaction, based on the distance between the user **504** and the system UI **508**. Details of the ray casting mode of interaction are provided, in FIG. **7**C.
(85) FIG. **7**C includes a diagram **7000** that depicts the interaction with the system UI **508** using the ray casting mode of interaction. The diagram **7000** includes the XR environment **502**A. The XR environment **502**A includes the system UI **508**. The XR environment **502**A further includes a representation **706** of a controller. The representation **706** of the controller may include a virtual line **708**. The system UI **508** further includes the set of UI elements **510**.
(86) The computing system may determine that the user **504** has moved such that the distance between the hand **504**A (or controller) of the user **504** and the surface of the system UI **508** is above a second threshold **710**. In such a case, the computing system may change the input mode from the direct touch mode of interaction to the ray casting mode of interaction.
(87) In an implementation, the first threshold **702** may be closer to the surface of the system UI **508** than the second threshold **710**. For example, the first threshold **702** may be 15 cm, and the second threshold **710** may be 25 cm. Thus, when the user **504** has moved such that the hand **504**A of the user **504** is more than the second threshold **710** in the XR environment **502**A, the computing system may change the input mode to the ray casting mode of interaction.
(88) In the ray casting mode of interaction, the virtual line **708** having a position based on the real-world location of the hand **504**A of the user **504**, interacts with elements of the set of UI elements **510**. The virtual line **708** may be a ray emerging from the representation **706** of the user's hand or controller. The virtual line **708** may be used as a reference by the user **504** to interact with the set of UI elements **510**. For example, the virtual line **708** may be used to interact with the UI element **712** of the set of UI elements **510**.
(89) In an exemplary scenario, as the distance between the user **504** and the surface of the system UI **508** is above the second threshold **710**, the user **504** is far from the system UI **508**. Thus, the user **504** may be unable to experience the direct touch mode of interaction. In such a case, the computing system provides the ray casting mode of interaction to the user **504**.
(90) Further, the computing system may modify the appearance of the system UI **508** to have a curved shape, in the ray casting mode of interaction. For example, the edge of the system UI **508** may be curved such that the display of the system UI **508** appears to be curved as well. Thus, in the

ray casting mode of interaction, the computing system provides the user **504** an experience of interacting with the system UI **508** from a faraway distance.

(91) In an implementation, the system UI **508** having the curved shape comprises a multi-screen display, for example a display **714**A and a display **714**B. In an exemplary scenario, the user **504** may use multiple applications simultaneously. For example, the display **714**A may be a web browser window. In another example, the display **714**A may display user interface of applications such as gaming applications, payment applications, shopping applications, and so forth. The display **714**B may display the user interface to access controls of the system UI **508**. For example, the user **504** utilize the display **714**B to set controls such as brightness, volume, and other controls settings for the system UI **508**. In an implementation, the multi-screen display may support 3 displays at once. In another implementation, the multi-screen display may support more than 3 displays at once. Thus, by the use of the multi-screen display on the system UI **508**, the user **504** may be able to utilize various applications at once without having to switch repeatedly between windows. Moreover, the size of the system UI **508** having the curved shape may be more than the size of the system UI **508** having the flat shape. As the system UI **508** is far away from the user **504** in the ray casting mode of interaction, viewing the curved shape with a large size multi-screen display may provide a comfortable viewing experience to the user **504**.

(92) Furthermore, the computing system may modify the appearance of the one or more of the set of UI elements **510** to have a two-dimensional (2D) (yet curved along the curved system UI surface) shape and to be a relative size defined based on the determined distance of the user **504** to the system UI **508**. For example, the UI elements closer to the user **504** on the system UI **508** may appear smaller as compared to the UI elements far from the user **504** on the system UI **508** having the curved shape. This relationship can be based on a defined relationship (e.g., linear and can have a defined maximum) that takes the distance and provides a magnification value. In an exemplary scenario, the UI elements near the curved edges of the system UI **508** may appear smaller as compared to the UI elements in a middle of the surface of the system UI **508**.

(93) In some implementations, in a case when the distance between the user **512** and the system UI **504** is between the first threshold **702** and the second threshold **710** (e.g., between 15 cm and 25 cm), the computing system keeps its previous input mode. In such a manner of implementing hysteresis, sudden, repeated switching between input modes and system UI display modes, as the user hovers close to a threshold, may be avoided. Moreover, the system UI **508** does not abruptly switch between the ray casting mode to direct touch mode of interaction between the first threshold **702** and the second threshold **710**, to avoid flickering or sudden transition between the input modes.

(94) FIG. **8** is a flow diagram of a method **800** used in some implementations for rotation of the system UI **508**. In an implementation, the method **800** may be triggered when the computing system and the XR device **506** are connected via the network **330**. Once the XR device **506** is activated by the user **504**, the computing system may display the XR environment **502**A on the XR device **506**. Moreover, the computing system may receive an input from the user **504** to render the system UI **508** in the XR environment **502**A.

(95) At block **802**, the system UI **508** is rendered as the 3D virtual element in the XR environment **502**A. For instance, the system UI **508** may be rendered at the position in the XR environment **502**A that is in front of the eye level of the user **512** at a preset default position, at a position defined by the user **504**, etc. The position of the rendered system UI **508** can be set such that it is within arms reach of the user **504**.

(96) At block **804**, the position of the hand **504**A of the user **504**, and a pre-defined stable point **512** on user **504**, is tracked by the computing system. The tracking of the position of the hand **504**A of the user **504**, and the pre-defined stable point **512**, may be performed based on positional data that is acquired using the one or more sensors (e.g., cameras, motion sensors, infrared sensors, etc.) present on or in communication with the XR device **506**. For example, the one or more sensors

may include imaging devices, such as cameras. Moreover, the tracking may be performed by use of the controllers **270**. In some implementations, the tracking may be based on or more kinematic models that defines possible movements of a user's body, allowing a machine learning model that receive input based on images of the user to use the kinematic model as constraints for possible positions of various parts of the user's body. In some cases, the machine learning model can use past known positions of parts of the user's body as input to perform time-based predictions of the user's movements. In some cases, image-based user tracking can be supplemented by or replaced with other forms of tracking, such as tracking based on wearables that sense motions of parts of the user's body. As additional sensor data is accumulated, the position of the representation **602** of the hand **504**A (or the controller) and the position of the stable point on the user is updated based on the tracking.

(97) At block **806**, in response to identifying that the hand **504**A of the user **504** has grasped the portion **604** of the system UI **508**, the computing system may rotate the position of the system UI **508** around the grasped portion **604** of the system UI **508**. The rotation of the position of the system UI **508** is performed such that the line **606** between the pre-defined stable point **512** and the surface of system UI **508**, is moved, to be at the perpendicular or at a predefined angle from the perpendicular to the surface of the system UI **508**, as the user **504** moves the system UI **508** via the grasped portion **604**. In some implementations, this rotation may occur only after the user has moved the system UI by a threshold amount and/or may perform the rotation at a given speed, allowing the system UI not to snap to the rotated position so quickly as to be jarring to the user.

(98) The method **800** may be implemented using corresponding processor of the computing system. In some implementations, a computer programmable product may be provided. The computer programmable product may comprise at least one non-transitory computer-readable storage medium having stored thereon computer-executable program code instructions that when executed by a computer, cause the computer to execute the method **800**.

(99) FIGS. **9**A and **9**B show a flow diagram of a method **900** used in some implementations for switching the input mode of the system UI **508** and modifying the appearance of the system UI **508**. In an implementation, the method **900** may be performed when a user enters an artificial reality environment, e.g., upon donning an XR device **506**. Once the XR device **506** is activated by the user **504**, the computing system may display the XR environment **502**A on the XR device **506**. Moreover, the computing system may receive an input from the user **504** to render the system UI **508** in the XR environment **502**A.

(100) At block **902**, the system UI **508** is rendered as the 3D virtual element in the XR environment **502**A. For instance, the system UI **508** may be rendered at a position in the XR environment **502**A that is in front of the eye level of the user **504** at a preset default position, at a position defined by the user **504**, etc. The system UI **508** comprises the set of UI elements **510** arranged on the surface of the system UI **508**. The position of the rendered system UI **508** can be set to a preset default position inbuilt in the XR device **506** and/or at the position defined by the user **504**. The position of the system UI **508** can be set such that it is within arms-reach of the user **504**.

(101) At block **904**, based on the tracked position of the user **504**, the distance is determined between the user **504** and the system UI **508**. The tracking may be performed based on the positional data that is acquired using the one or more sensors (e.g., cameras, motion sensors, infrared sensors, etc.) present on or in communication with the XR device **506**. For example, the one or more sensors may include imaging devices, such as cameras. Moreover, the tracking may be performed by use of the controllers **270**. In some implementations, the tracking may be based on or more kinematic models that defines possible movements of a user's body, allowing a machine learning model that receive input based on images of the user to use the kinematic model as constraints for possible positions of various parts of the user's body. In some cases, the machine learning model can use past known positions of parts of the user's body as input to perform time-based predictions of the user's movements. In some cases, image-based user tracking can be

supplemented by or replaced with other forms of tracking, such as tracking based on wearables that sense motions of parts of the user's body. As additional sensor data is accumulated, the position of the representation **602** of the hand **504**A (or the controller) and the position of the stable point on the user is updated based on the tracking. In an implementation, the distance between the user **504** and the system UI **508**, is determined based on the distance between the hand **504**A of the user **504** and the surface of the system UI **508**.
(102) At block **906**, the computing system can determine if the distance is below the first threshold **702** (e.g., inside the distance of the determined typical arm length or the determined length of the arm of the user **504**). For example, the computing system determines the distance, when a movement of the hand **504**A of the user **504** is detected. In response to determining that the distance is below the first threshold **702**, further steps are performed which are explained at block **908** (further divided in substeps **908**A, **908**B and **908**C).
(103) At block **908**A, when the distance between the user **504** and the system UI **508** is below the first threshold **702**, the computing system is configured to change the input mode from the ray casting mode of interaction to the direct touch mode of interaction. In the direct touch mode of interaction, based on the tracked real-world location of the hand **504**A of the user **504**, the representation **602** of the hand **504**A of the user **504** interacts with the UI elements of the set of UI elements **510**.
(104) At block **908**B, the computing system is configured to modify the appearance of the system UI **508** to have the flat shape. For example, the edge of the system UI **508** may be flat such that a display of the system UI **508** appears to be flat. In an implementation, in the direct touch mode of interaction, the system UI **508** having the flat shape comprises the single screen display which can be grabbed and moved by the user. As the system UI **508** is close to the user **504** (and may be held by another hand of the user) in the direct touch mode of interaction, viewing the single screen display may provide a comfortable viewing experience to the user **504**.
(105) At block **908**C, the computing system is configured to modify the appearance of one or more of the set of UI elements **510** to have the 3D shape and to be the fixed size defined for each of the one or more of the set of UI elements **510**. The 3D shape may enable the set of UI elements **510** to be at a height from the surface of the system UI **508**. The set of UI elements **510** may be shown in the 3D shape such that the user **504** may easily identify which UI element to target. Moreover, the size of the set of UI elements **510** may be fixed, and in some embodiments, the size of the selected UI element may be increased.
(106) At block **910**, based on the determination that the distance is above the first threshold **702**, the computing system is configured to determine if the distance is above the second threshold **710**. For example, the determination of the distance above the second threshold **710** may also be based on the determined length of the typical arm or the determined length of the arm of the user **504**. In response to determining that the distance is not above the second threshold, process **900** can end. Process **900** can be performed again iteratively, e.g., as the user moves and as the system UI continues to be displayed.
(107) At block **914**A, when the distance between the user **504** and the system UI **508**, is above the second threshold **710**, the computing system is configured to change the input mode from the direct touch mode of interaction to the ray casting mode of interaction. In the ray casting mode of interaction, the virtual line **708** having a position based on the real-world location of the hand **504**A of the user **504**, interacts with the UI elements of the set of UI elements **510**. The virtual line **708** may be a ray emerging from the representation **706** of the user's hand or the controller. The virtual line **708** may be used as a reference by the user **504** to interact with the set of UI elements **510**. For example, the virtual line **708** may be used to interact with the UI element **712** of the set of UI elements **510**.
(108) At block **914**B, the computing system is configured to modify the appearance of the system UI **508** to have the curved shape. For example, the edge of the system UI **508** may be curved such

that the display of the system UI **508** appears to be curved as well. Thus, in the ray casting mode of interaction, the computing system provides the user **504** an experience of interacting with the system UI **508** from a faraway distance. In an implementation, the system UI **508** having the curved shape comprises a multi-screen display, for example, the display **714**A and the display **714**B. Notably, by use of the multi-screen display on the system UI **508**, the user **504** may be able to utilize various applications at once without having to switch repeatedly between windows.

(109) At block **914**C, the computing system is configured to modify the appearance of one or more of the set of UI elements **510** to have to have the 2D (yet curved along the curved system UI surface) shape and to be a relative size defined based on the determined distance of the user **504** to the system UI **508**. For example, the UI elements closer to the user **504** on the system UI **508** may appear smaller as compared to the UI elements far from the user **504** on the system UI **508** having the curved shape. This relationship can be based on a defined relationship (e.g., linear and can have a defined maximum) that takes the distance and provides a magnification value. Thus, based on the distance between the user **504** and the system UI **508**, the computing system enables switching of the input modes and the display mode of the system UI **508**, without causing flickering, thereby providing an enhanced user experience to the user **504**.

(110) The method **900** may be implemented using corresponding processor of the computing system. In some implementations, a computer programmable product may be provided. The computer programmable product may comprise at least one non-transitory computer-readable storage medium having stored thereon computer-executable program code instructions that when executed by a computer, cause the computer to execute the method **900**.

(111) FIG. **10** is a conceptual diagram **1000** illustrating various implementations and configurations of the system UI. FIG. **10** includes four versions of the system UI. Version **1012** includes the system UI being displayed as a handheld virtual object that the user **1002** can hold with one hand **1004** and interact with the other. Additional details on system UI version **1012** are provided below in relation to FIG. **11**A. Version **1010** includes the system UI being displayed as a set of separate UI elements and controls, such as elements and controls **1010**A and **1010**B, that are locked in place around a user **1002**'s field of view. Additional details on system UI version **1010** are provided below in relation to FIG. **11**B. Version **1008** includes the system UI being displayed as a set of multiple windows **1008**A-**1008**C, enabling multitasking and simultaneous access to multiple applications or information sources. Additional details on system UI version **1008** are provided below in relation to FIG. **11**C. Version **1006** includes the system UI being displayed as a large head-locked or world-locked screen, providing an immersive content viewing experience. Additional details on system UI version **1006** are provided below in relation to FIG. **11**D.

(112) FIGS. **11**A-**11**D are conceptual diagrams **1100**, **1110**, **1120**, and **1130**, each further illustrating one of the various implementations and configurations of the system UI. In various implementations, the system UI configurations shown in conceptual diagrams **1100**, **1110**, **1120**, and **1130** can be mapped to be used as a user is identified as being in various contexts—such as VR immersive applications, mixed reality or augmented reality experiences, in a specified home environment, situations specified as needing certain screen size interfaces, occlusion parameters, or user input modalities. For example, the heads-up configuration, where the system UI is displayed as a set of separate UI elements and controls locked in place around a user's field of view, can be used in a context defined for the user to need both hands free or have limited attention for system controls and thus is in need of glanceable info; the tablet configuration, where the system UI is displayed as a handheld virtual object that the user can hold with one hand and interact with the other, can be used as the default mode; the multi-screen configuration, where the system UI is displayed as a set of multiple windows, can be used in a context where the user may be multitasking; and the theater screen configuration, where the system UI is displayed as a large head-locked or world-locked screen, can be used in a context where the user is viewing content items such as a movie or immersive media.

(113) FIG. **11**A illustrates the system UI **1102** being displayed as a handheld virtual object that the user can hold with one hand and interact with, with the other hand. The system UI configuration shown in FIG. **11**A can be triggered when the user first enables the system UI, when the user performs a gesture to grab a portion of the system UI shown in a different configuration, upon a voice command or UI element activation to enter this system UI mode, etc. The system UI in this configuration can include various system controls, access to applications (e.g., area **1106**), tools and utilities such as accounts and payment methods (e.g., area **1104**), links to travel to various metaverse destinations, the user's content items, controls to move and set the look and accessories of the user's avatar, etc. The user can hold this system UI **1102** by making a grab gesture with the user's physical hand, which allows the user to move the system UI **1102** in six-degrees of freedom and position it in a manner that facilitates easy viewing and interaction with the user's other hand. If the user lets go of the system UI **1102**, in various implementations, it may disappear, become world locked at the location it was released, move to a default location, or transition into another state such as one of the states shown in FIGS. **11**B-**11**D.
(114) FIG. **11**B includes the system UI being displayed as a set of separate UI elements and controls that are locked in place around a user field of view. The system UI configuration shown in FIG. **11**B can be triggered when the user first enables the system UI, when the user closes the system UI from another of the modes shown in FIG. **11**A, **11**C, or **11**D, upon a voice command or UI element activation to enter this system UI mode, etc. In FIG. **11**B, the user's field of view (i.e., the area of the real or virtual world that the user can see through her artificial reality device) is illustrated as rectangle **1114**. In the example shown, the system UI has been split into several UI elements including system controls **1116** and notifications **1112**. The system UI in this configuration can pop up additional UI elements that can be locked to a particular area in the user's field of view as they are surfaced by the system controller or other executing applications The system UI can revert to another of the system UI modes when one of them are activated as discussed herein.
(115) FIG. **11**C includes the system UI being displayed as a set of multiple windows **1122-1126**, enabling multitasking and simultaneous access to multiple applications or information sources. The system UI configuration shown in FIG. **11**C can be triggered when the user first enables the system UI, when the user performs a gesture such as throwing the tablet version of the system UI or stretching the tablet version of the system UI with an opening all five fingers gesture or a two-handed pull apart gesture, upon a voice command or UI element activation to enter this system UI mode, etc. The system UI in this configuration can show multiple windows where the user can select what to show in each such as a web browser or 2D version of another other application (e.g., window **1126**), content items such as a document, video, or image or libraries of such content items, a list of contacts or other social media content (e.g., window **1122**), news feeds, installed applications (e.g., window **1124**), controls to navigate to various metaverse destinations, avatar setup and controls, etc. In some implementations, this configuration of the system UI can also include a launcher bar **1128**, e.g., with quick access controls, settings, system status and notifications controls, etc. The system UI can close or transition to another of the configurations shown in FIG. **11**A, **11**B, or **11**D upon a user command or gesture to do so.
(116) FIG. **11**D includes the system UI being displayed as a large head-locked or world-locked screen, providing an immersive content viewing experience. The system UI configuration shown in FIG. **11**D can be triggered when the user first enables the system UI, when the user opens a content item in the system UI configured for this mode, starts an application or experience setup to provide content items via the system UI in this mode, upon a user gesture to throw the system UI or further stretch the system UI above a threshold size (e.g., by stretching another version of the system UI with an opening all five fingers gesture or a two-handed pull apart gesture above a threshold size), upon a voice command or UI element activation to enter this system UI mode, etc. The system UI in this configuration can provide a fully immersive experience showing a content item or can show

a large virtual screen, such as screen **1132**, showing a content item **1134**. In some implementations, the system UI in this configuration can include additional system UI elements **1136** such as system controls, notifications, co-watching elements, etc. The system UI in this configuration can be world locked so it appears to stay in the same place as the user moves about the world (which may include keeping the screen facing the user) or can be body locked so it appears to stay the same distance from the user as the user moves about the world. The system UI from this configuration can close or transition to another of the system UI configurations e.g., when selected by the user with a grab gesture, in response to a command to close with a voice or UI activation, etc.

(117) Several implementations of the disclosed technology are described above in reference to the figures. The computing devices on which the described technology may be implemented can include one or more central processing units, memory, input devices (e.g., keyboard and pointing devices), output devices (e.g., display devices), storage devices (e.g., disk drives), and network devices (e.g., network interfaces). The memory and storage devices are computer-readable storage media that can store instructions that implement at least portions of the described technology. In addition, the data structures and message structures can be stored or transmitted via a data transmission medium, such as a signal on a communications link. Various communications links can be used, such as the Internet, a local area network, a wide area network, or a point-to-point dial-up connection. Thus, computer-readable media can comprise computer-readable storage media (e.g., "non-transitory" media) and computer-readable transmission media.

(118) Reference in this specification to "implementations" (e.g. "some implementations," "various implementations," "one implementation," "an implementation," etc.) means that a particular feature, structure, or characteristic described in connection with the implementation is included in at least one implementation of the disclosure. The appearances of these phrases in various places in the specification are not necessarily all referring to the same implementation, nor are separate or alternative implementations mutually exclusive of other implementations. Moreover, various features are described which may be exhibited by some implementations and not by others. Similarly, various requirements are described which may be requirements for some implementations but not for other implementations.

(119) As used herein, being above a threshold means that a value for an item under comparison is above a specified other value, that an item under comparison is among a certain specified number of items with the largest value, or that an item under comparison has a value within a specified top percentage value. As used herein, being below a threshold means that a value for an item under comparison is below a specified other value, that an item under comparison is among a certain specified number of items with the smallest value, or that an item under comparison has a value within a specified bottom percentage value. As used herein, being within a threshold means that a value for an item under comparison is between two specified other values, that an item under comparison is among a middle specified number of items, or that an item under comparison has a value within a middle specified percentage range. Relative terms, such as high or unimportant, when not otherwise defined, can be understood as assigning a value and determining how that value compares to an established threshold. For example, the phrase "selecting a fast connection" can be understood to mean selecting a connection that has a value assigned corresponding to its connection speed that is above a threshold.

(120) As used herein, the word "or" refers to any possible permutation of a set of items. For example, the phrase "A, B, or C" refers to at least one of A, B, C, or any combination thereof, such as any of: A; B; C; A and B; A and C; B and C; A, B, and C; or multiple of any item such as A and A; B, B, and C; A, A, B, C, and C; etc.

(121) Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Specific embodiments and implementations have been described herein for purposes of illustration, but

various modifications can be made without deviating from the scope of the embodiments and implementations. The specific features and acts described above are disclosed as example forms of implementing the claims that follow. Accordingly, the embodiments and implementations are not limited except as by the appended claims.
(122) Any patents, patent applications, and other references noted above are incorporated herein by reference. Aspects can be modified, if necessary, to employ the systems, functions, and concepts of the various references described above to provide yet further implementations. If statements or subject matter in a document incorporated by reference conflicts with statements or subject matter of this application, then this application shall control.

Claims

1. A method for facilitating system user interface (UI) interactions in an artificial reality (XR) environment, the method comprising: rendering the system UI as a 3D virtual element in the XR environment, wherein the system UI comprises a set of UI elements arranged on a surface of the system UI; determining, based on a tracked position of the user, a distance between a hand of the user and the system UI; and in response to the determining that the distance between the hand of the user and the system UI is below a first threshold: changing an input mode from a ray casting mode of interaction to a direct touch mode of interaction in which a representation of the hand of the user, which tracks the real-world location of the hand of the user, interacts with UI elements of the set of UI elements; modifying an appearance of the system UI to have a flat shape; and modifying an appearance of one or more of the set of UI elements to have a three-dimensional shape and to be a fixed size defined for that one of the one or more of the set of UI elements.
2. The method of claim 1, wherein the distance between the user and the system UI is determined based on at least a distance between a finger tip of the user and the surface of the system UI.
3. The method of claim 1, further comprising: in response to determining that the user has moved such that the distance is above a second threshold: changing the input mode from the direct touch mode of interaction to the ray casting mode of interaction in which a virtual line, having a position based on the real-world location of the hand of the user, interacts with elements of the set of UI elements; modifying an appearance of the system UI to have a curved shape; and modifying an appearance of one or more of the set of UI elements to have a two-dimensional shape and to be a relative size defined based on the determined distance of the user to the system UI.
4. The method of claim 3, wherein the system UI having the flat shape comprises a single screen display and wherein the system UI having the curved shape comprises a multi-screen display.
5. The method of claim 3, wherein the first threshold is closer to the surface of the system UI than the second threshold.
6. The method of claim 3, wherein tracking of the position of the user is based on at least one of: one or more sensors that detect gestures of the hand of the user in real-time, or one or more controllers associated with an XR device that renders the XR environment.
7. The method of claim 1, wherein the determining that the distance between the hand of the user and the system UI is below the first threshold comprises determining that the hand of the user is in contact with the system UI.
8. A computer-readable storage medium storing instructions that, when executed by a computing system, cause the computing system to perform a process for facilitating system user interface (UI) interactions in an artificial reality (XR) environment, the process comprising: rendering the system UI as a 3D virtual element in the XR environment, wherein the system UI comprises a set of UI elements arranged on a surface of the system UI; determining, based on a tracked position of the user, a distance between a hand of the user and the system UI; and in response to determining that the distance is below a first threshold: changing an input mode from a ray casting mode of interaction to a direct touch mode of interaction in which a representation of the hand of the user,

which tracks the real-world location of the hand of the user, interacts with UI elements of the set of UI elements; modifying an appearance of the system UI to have a flat shape; and modifying an appearance of one or more of the set of UI elements to have a three-dimensional shape and to be a fixed size defined for that one of the one or more of the set of UI elements.
9. The computer-readable storage medium of claim 8, wherein the distance between the user and the system UI is determined based on at least a distance between a finger tip of the user and the surface of the system UI.
10. The computer-readable storage medium of claim 8, wherein the process further comprises: in response to determining that the user has moved such that the distance is above a second threshold: changing the input mode from the direct touch mode of interaction to the ray casting mode of interaction in which a virtual line, having a position based on the real-world location of the hand of the user, interacts with elements of the set of UI elements; modifying an appearance of the system UI to have a curved shape; and modifying an appearance of one or more of the set of UI elements to have a two-dimensional shape and to be a relative size defined based on the determined distance of the user to the system UI.
11. The computer-readable storage medium of claim 10, wherein the system UI having the flat shape comprises a single screen display and wherein the system UI having the curved shape comprises a multi-screen display.
12. The computer-readable storage medium of claim 10, wherein the first threshold is closer to the surface of the system UI than the second threshold.
13. The computer-readable storage medium of claim 10, wherein tracking of the position of the user is based on at least one of: one or more sensors that detect gestures of the hand of the user in real-time, or one or more controllers associated with an XR device that renders the XR environment.
14. The computer-readable storage medium of claim 8, wherein the determining that the distance between the hand of the user and the system UI is below the first threshold comprises determining that the hand of the user is in contact with the system UI.
15. A computing system for facilitating system user interface (UI) interactions in an artificial reality (XR) environment, the computing system comprising: one or more processors; and one or more memories storing instructions that, when executed by the one or more processors, cause the computing system to perform a process comprising: rendering the system UI as a 3D virtual element in the XR environment, wherein the system UI comprises a set of UI elements arranged on a surface of the system UI; determining, based on a tracked position of the user, a distance between a hand of the user and the system UI; and in response to determining that the distance is below a first threshold: changing an input mode from a ray casting mode of interaction to a direct touch mode of interaction in which a representation of the hand of the user, which tracks the real-world location of the hand of the user, interacts with UI elements of the set of UI elements; modifying an appearance of the system UI to have a flat shape; and modifying an appearance of one or more of the set of UI elements to have a three-dimensional shape and to be a fixed size defined for that one of the one or more of the set of UI elements.
16. The computing system of claim 15, wherein the distance between the user and the system UI is determined based on at least a distance between a finger tip of the user and the surface of the system UI.
17. The computing system of claim 15, wherein the process further comprises: in response to determining that the user has moved such that the distance is above a second threshold: changing the input mode from the direct touch mode of interaction to the ray casting mode of interaction in which a virtual line, having a position based on the real-world location of the hand of the user, interacts with elements of the set of UI elements; modifying an appearance of the system UI to have a curved shape; and modifying an appearance of one or more of the set of UI elements to have a two-dimensional shape and to be a relative size defined based on the determined distance of the

user to the system UI.
18. The computing system of claim 17, wherein the system UI having the flat shape comprises a single screen display and wherein the system UI having the curved shape comprises a multi-screen display.
19. The computing system of claim 17, wherein the first threshold is closer to the surface of the system UI than the second threshold.
20. The computing system of claim 17, wherein tracking of the position of the user is based on at least one of: one or more sensors that detect gestures of the hand of the user in real-time, or one or more controllers associated with an XR device that renders the XR environment.