January 23, 2019

Mode selection for augmented reality application to control access to real-world data

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ABSTRACT

In situations where virtual, mixed, augmented, and extended reality applications or services are operated by remote providers, images, video, and/or other world-understanding data captured by a camera or other sensors of a user device may be made available to the applications to enable integration of virtual objects with the user's real world surroundings. It is important to allow users control over how the video generated by the camera is provided to such applications. Current application configuration settings such as permissions to access camera usually offer a binary choice that requires the user to provide the requested access or forego using the application entirely. This disclosure describes techniques that allow the user to choose the application mode prior to beginning an interactive session. The choice of mode controls the level of detail about the user's real world surroundings that is made available to the application.

KEYWORDS

- Virtual reality (VR)
- Mixed reality (MR)
- Augmented reality (AR)
- Extended reality (XR)
- WebXR
- Mode selection
- User permission
- Camera permission
- Privacy

BACKGROUND

Applications and services that utilize Virtual Reality/ Mixed Reality/ Augmented Reality/ Extended Reality (VR/MR/AR/XR) technologies involve combining virtual objects with real world image data. These technologies form a spectrum with varying levels of combinations of the virtual and the real.

At one end of the spectrum, VR experiences do not show the real world at all. However, user motion in the real world is translated 1:1 to the movements in the virtual world. For instance, in a VR scenario, the user may be physically walking around in the real world while holding a real object. Such a VR system often still needs real-world awareness, such as floor height to place virtual objects at appropriate locations and boundaries to stop the user from running into walls or objects. The VR system may include additional tracked objects, such as weapon props that appear in both the real and virtual worlds.

At the other end of the spectrum, AR experiences may mostly show the real world with a few virtual objects added to the scene or real-world objects being modified with added functionality or information. For example, an AR system may project a hole onto a real-world wall to show a scene behind the wall. The AR system needs to understand the physical world to ensure that virtual and real objects appear consistently. MR systems cover the spectrum in between VR and AR with a variety of possible mixed experiences that involve varying amounts of integration between the real and virtual worlds. The term "mixed reality" or MR is also used as a term that covers the entire spectrum of related technologies, including AR, VR, and XR.

Data to understand the real world needed for many VR/AR/XR experiences is typically obtained via a camera of a user device (or other cameras in the user's environment). The camera captures still images and/or video streams that are provided to the VR/AR/XR system. Such data are utilized to capture, understand, and model the physical properties of the user's real-world surroundings. World understanding can also come from other sensors, including non-imaging laser systems such as LIDAR, acoustic sensors, etc. Users may prefer to restrict access to such data, similar to data obtained from the camera, especially if the data is of a comparable level of quality.

In situations where the VR/AR/XR applications or services are operated by remote providers, the images and/or video captured by the camera are available to the application and can potentially be sent to the providers. In these situations, data about the user's real world surroundings may be transmitted to remote providers. User permission to obtain and potentially send such data is important to ensure user privacy.

However, in many cases, a user may not need the real-world integration for which the applications request camera access. For example, a simple view of what a virtual object looks like can be provided without the viewing application having access to the camera feed of the user's location, for example, by having the application draw the virtual object on a transparent background, and then the system combines that with the camera image in a separate step where the end result is shown to the user but is not accessible to the application. Even when the application experience is capable of advanced integration, such as showing realistic reflections on a shiny metal statue, some users user may find this additional realism worth trading off privacy by allowing camera access to a trusted application, while other users may prefer a lower quality of experience in exchange for not being required to provide camera access.

It is possible to configure VR/AR/XR applications to work with varying levels of camera and/or sensor access. For instance, VR/AR/XR content deployed on the web via WebXR is usually designed to work with a variety of hardware capabilities. Currently, before initiating

VR/AR/XR applications, the set of available features is requested and the application session is configured based on such features. Such operations involve configuring the user device before launching the VR/AR/XR application. For example, a global option can enable or disable camera access to the application. Current application configuration settings such as permissions to access camera usually offer a binary choice that requires the user to provide the requested access or forego using the application entirely.

DESCRIPTION

This disclosure describes techniques that allow the user to choose an appropriate mode of VR/AR/XR experience prior to beginning an interactive session. The choices of mode controls the level of detail about the user's real world surroundings that is made available to the application via the camera and other device sensors, with the user's permission. The techniques thus allow the user to choose modes that correspond to a desired level of privacy protection. Limiting access to the features of a device in this manner makes a more capable user device equivalent to a device with hardware limitations operating at its full capability. Since many VR/AR/XR applications can adapt their operation to accommodate devices with various hardware limitations, such applications can function even when access to the full features of a more capable device is restricted.

Before initiating an interactive VR/AR/XR session, an interstitial screen is displayed locally on the user device. The interstitial screen allows the user to choose from different choices of interactive experiences. The presented choices depict the expected user experience (UX) and indicate the data that will be made available to the VR/AR/XR application if the user selects the particular mode. For instance, the choices can include virtual reality mode (VR mode), augmented reality mode (AR mode) with restricted world understanding, AR with detailed world understanding including live camera images or environment maps, etc.

If the user chooses the VR mode, or a minimal AR mode, with the user's permission the application is provided minimal real-world geometry information, such as floor position, headset and controller poses relative to the floor, and/or an arbitrary origin, and a simple set of boundaries such as a 'safe space' rectangle or circle. In response to the user choosing an AR mode with coarse world understanding, the application is provided access to a coarse representation of the world, such as a tessellation into a triangle grid. In this mode, the user may still see a camera view of the surroundings, but this is a local overlay that is inaccessible to the VR/AR/XR application. If the user chooses an advanced AR mode, the application is allowed full access to the available real-world geometry data and/or a camera feed. While the foregoing discussion refers to specific modes and corresponding access to data, other modes and/or different levels of application access to real-world data within a particular mode are possible.

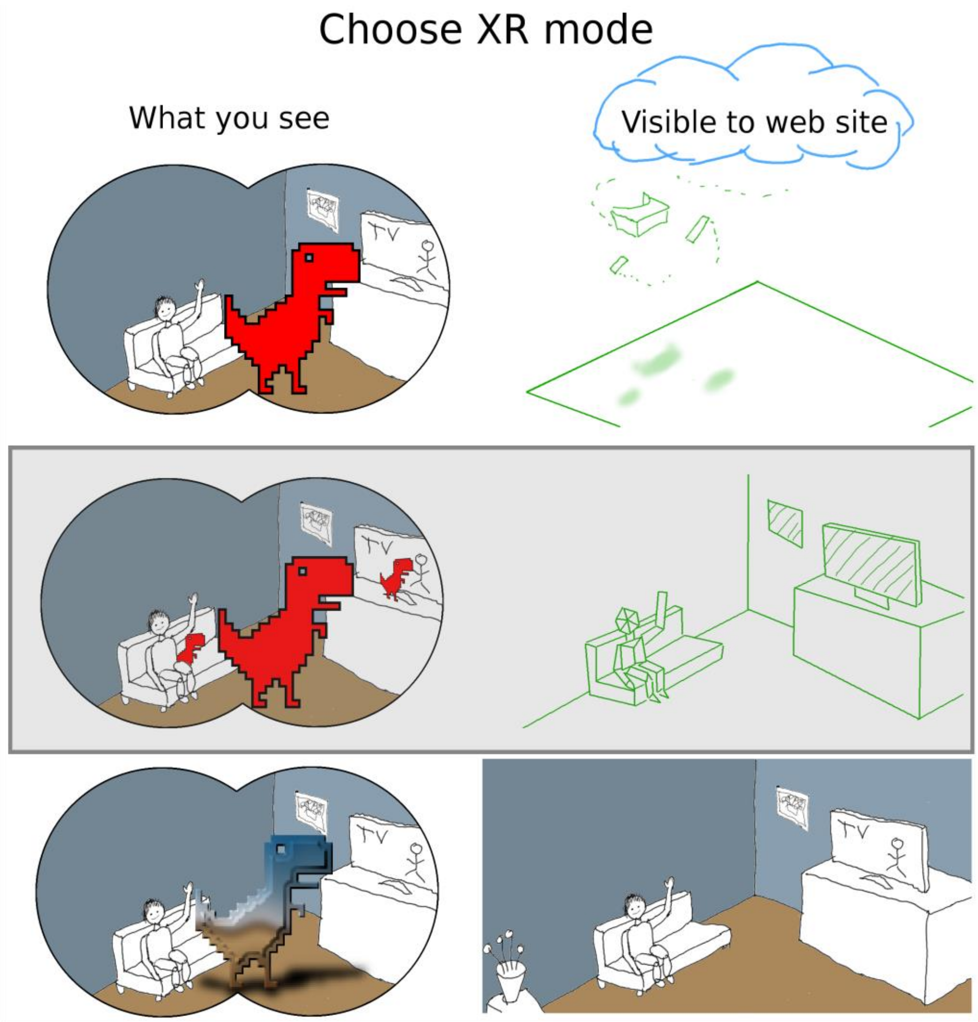

Fig. 1: Interstitial screen of VR/AR/XR modes with different levels of privacy protection

Fig. 1 shows example virtual worlds, with data access controlled as described above. Prior to launching the interactive session for the VR/AR/XR application, the user is shown the interstitial screen shown in Fig. 1, e.g., by local software on the user's device. The example shown in Fig. 1 presents the users with a choice of three modes, augmented reality (AR) without world understanding, AR with coarse world understanding, and AR with detailed world understanding including image data from top to bottom. In the example shown in Fig. 1, the "red/chrome dinosaur" is a virtual object. The modes shown in Fig. 1 are examples, other modes are also applicable here such as a pure VR mode where the environment isn't visible to the user.

Each mode is presented to depict the interactive experience as seen from the user's point of view (left column in Fig. 1) and the information about the user's physical surroundings (right column in Fig. 1) made available to the application , website, or service provider delivering the VR/AR/XR experience. As Fig. 1 shows, the fidelity of the interactive experience as well as the corresponding level of access to private data of the modes increases from top to bottom.

In the first row, the application only knows about a simple floor rectangle indicating an overall boundary of available space, along with position/orientation of the user's head and tracked controllers. The second row adds approximate world understanding based on a coarse representation, allowing the application to place objects on furniture in the user's environment and handling basic occlusion between real and virtual objects. The third row makes camera images available to the application, allowing advanced effects such as global illumination, reflection and refraction where virtual objects appear fully integrated in the real scene.

Once the user has selected the mode, data from device sensors and camera are provided to the VR/AR/XR application, with the mode-specific restrictions. If the user permits, the required features are matched against capabilities of the user's hardware and previously specified user preferences, if any. Such specified user preferences can include defaults or restrictions such as globally forbidding camera access for all applications, configuration for specific sites or applications, access exceptions for trusted sites or application providers, settings used during a previous VR/AR/XR session, etc.

The mode selected by the user is used to override the level of data access requested by the VR/AR/XR application, even if the user's hardware is capable of providing the requested level of data. Based on the mode chosen by the user, the session is downgraded to a reduced functionality set. As long as the reduced functionality is reasonable (since restricted data access works similar to how the application works on devices with other classes of hardware), the application does not need special support or modification to accommodate the operation.

For example, if the user selects VR mode or basic AR mode to display a 3D model without advanced real-world integration, e.g., provided by a VR/AR/XR application site not associated with a high level of user trust, the site is denied access to camera data even if the user's device is equipped with a camera. In contrast, if the user permits, in the AR mode, a video conferencing application from a highly trusted provider is allowed access to real-world geometry and camera data.

The techniques described above can be extended by determining the mode that best suits the user's needs and preferences. If the user permits, such determination can be made based on available contextual information, such as the user's real-world situation, user-specified preferences, user profile data etc. The mode determined as suitable for the user's purposes can be shown as a recommended mode on the interstitial screen that is used for mode selection.

Since user selection of mode is enabled by the interstitial screen presented by software executing locally on the device (e.g., a web browser, a device operating system, etc.). the VR/AR/XR application does not need to be modified in order to support mode selection. The interstitial screen can use text, still images, animation, videos, or any other form of information delivery suitable to convey an explanation of the UX and the corresponding data disclosure of data. Further, the interstitial screen can also provide options for the user to not start a VR/AR/XR session at all, in which case no data is provided to the application.

The interstitial screen can also be utilized for mode selection when the user has multiple device choices available. For example, a user can choose between 3-degrees-of-freedom VR experience by inserting their smartphone into a head-mounted viewer and 6-degrees-of-freedom

AR experience by directly using the smartphone without the viewer. Alternately, with the user's permission controller locomotion can be utilized to provide a pseudo 6-degrees-of-freedom mode on a 3-degrees-of-freedom VR headset. Such a mode can also improve accessibility for users with mobility restrictions.

The techniques of this disclosure can be extended to support additional modes. For example, there can be separate modes to distinguish between live real-world geometry based on the camera view from the user's headset or persisted maps with multi-room tracking capability. Similarly, modes with low-quality camera feeds can be used as the basis of reflection or ambient occlusion effects. Since the techniques require no operational modifications to VR/AR/XR applications, existing applications continue to work as additional modes are added and can take advantage of the new modes automatically without any changes to the application code.

Predefined configurations as implemented in current VR/AR/XR applications require the user to remember to configure device settings prior to starting a VR/AR/XR session. Alternatively, the device can provide physical switches to control hardware capabilities. However, such an approach does not eliminate the need to remember to configure device settings prior to starting a VR/AR/XR session. Further, users may not choose the correct configuration if the switches do not make the current mode readily apparent.

The risks of forgetting to configure settings appropriately or making errors can be high. For instance, if the VR/AR/XR application has access to a high quality camera feed of the user's real-world environment, information that the user does not wish to share with the application may be captured and shared with the application provider and other parties. The techniques described in this disclosure requires explicit mode choice from the user prior to each VR/AR/XR session and ensures that user choices are explicit, informed, and intuitive, and therefore, offers user greater control over the data that is shared with applications that provide the session.

The techniques can be implemented on a variety of hardware and software platforms, such as web browsers, mobile and desktop headsets, mobile devices such as smartphones and tablets, desktop computers, specialized VR/AR/XR equipment, etc. The techniques can support applications that utilize the WebXR API.

Further to the descriptions above, a user may be provided with controls allowing the user to make an election as to both if and when systems, programs or features described herein may enable collection of user information (e.g., information about a user's social network, social actions or activities, profession, a user's preferences, or a user's current location), and if the user is sent content or communications from a server. In addition, certain data may be treated in one or more ways before it is stored or used, so that personally identifiable information is removed. For example, a user's identity may be treated so that no personally identifiable information can be determined for the user, or a user's geographic location may be generalized where location information is obtained (such as to a city, ZIP code, or state level), so that a particular location of a user cannot be determined. Thus, the user may have control over what information is collected about the user, how that information is used, and what information is provided to the user.

CONCLUSION

This disclosure describes techniques that allow the user to choose the application mode prior to beginning an interactive session of a virtual, mixed, augmented, or extended reality application. The choice of mode controls the level of detail about the user's real world surroundings that is made available to the application and allow users to restrict the information provided to the application. The mode choices are presented by software on the user's local device and depict the expected user experience (UX) and corresponding data to be made available to the application. Based on the mode selection made by the user, the application is provided with hardware access to obtain data that corresponds to the user's chosen UX and privacy settings. The applications do not need special support for mode selection as described herein. The explicit mode choice is offered to the user prior to each application session and ensures that user choices are explicit, informed, and intuitive. The techniques can be implemented on a variety of hardware and software platforms.

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