January 2021

Smooth Transitioning Between Augmented and Virtual Reality

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ABSTRACT

This disclosure describes techniques that enable a user to start in an augmented reality (AR) environment (where virtual objects can be observed in their physical surroundings) and move to a virtual reality (VR) environment (where virtual objects alone can be examined from various perspectives in detail or from a distance). The user can make the reverse VR-to-AR journey as well. The AR↔VR transitioning and the examination of objects from various perspectives is made possible by smooth transformations of scale and of rotation between the coordinates of the world (e.g., the scene) and the object.

KEYWORDS

- Augmented reality (AR)
- Virtual reality (VR)
- Extended reality (XR)
- Mixed reality (MR)
- Immersive computing
- Virtual co-location
- Virtual collaboration

BACKGROUND

Augmented reality, virtual reality, extended reality, and mixed reality (AR/VR/XR/MR) has applications in various domains, e.g., industrial design, architecture, event planning, gaming, etc. For example, an aircraft designer can virtually and remotely test the fit of a newly-designed component to an existing physical airframe. An event planner can virtually and remotely test the suitability of a particular stage prop to a stage setting. A team of workers, some on-site and some remote, can collaborate to simultaneously analyze a scene, e.g., a building under construction, without observational inconsistencies. In such situations, smoothly transitioning from an augmented world view to the virtual world view can enhance user productivity.

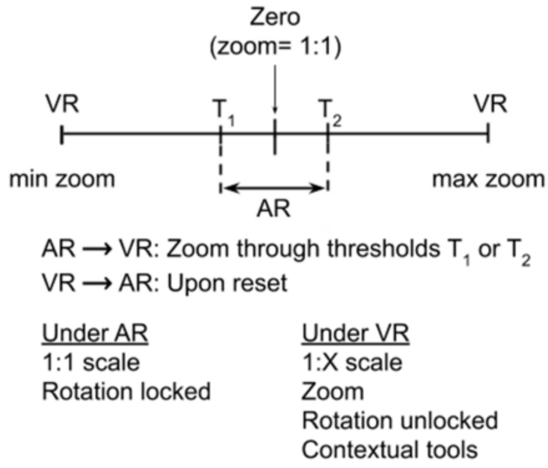
DESCRIPTION

This disclosure describes techniques that enable a user to start in an augmented reality (AR) environment (where virtual objects can be observed in their physical surroundings) and move to a virtual reality (VR) environment (where virtual objects alone can be examined from various perspectives in detail or from a distance). The user can make the reverse VR-to-AR journey as well. The AR↔VR transitioning and the examination of objects from various perspectives is made possible by smooth transformations of scale and of rotation between the coordinates of the world (e.g., the scene) and the object.

Per the techniques, a user can move from the setting (or scene) to the object, from the general to the particular, and vice-versa. For example, an aircraft designer can virtually view the entire aircraft, then, cutting out the physical airframe, virtually and rapidly zoom into a newly-designed (virtual) component to inspect it from various angles. An event planner can virtually peruse the entire physical stage, then cut out the physical stage, zoom in close to the virtual stage prop, examine it, virtually pick it up, re-activate the physical stage, and place the virtual stage prop elsewhere on the physical stage.

Alternatively, a user can also take a virtual object out of a scene and bring it towards them for the purposes of inspection, audit, review, annotation, or creation. Users jointly observing an augmented reality environment share the coordinate space of the virtual objects, such that annotations, perspective-changes, or modifications made to a virtual object are simultaneously viewable by other users. This mode of locomotion, where the virtual object is brought towards the user (rather than the other way round), is useful if the object is situated at an unreachable location in physical space, or is partially or fully hidden behind other real or virtual objects.

(a)



(b)

Fig. 1: Transitioning between VR and AR (a) Controller (b) Abstract representation of VR↔AR transitioning via a zoom mechanism

The techniques described herein can be implemented to provide viewing experiences on AR or VR devices, e.g., smart glasses, VR headsets, etc. Such devices include binocular passthrough cameras and inertial measurement units. Fig. 1 illustrates techniques for transitioning between AR and VR. The user is provided with one or more controllers, e.g., one for each hand, as illustrated in Fig. 1(a).

A zoom gesture or a movement of a controller button or stick results in a VR↔AR transition, as illustrated in Fig. 1(b). When the controller stick is at zero position or within an upper (T_2) or lower (T_1) threshold from zero, the headset is in AR mode, e.g., the cameras pass through their feed to the near-eye display, and virtual objects, if any, are superposed on the real scene. In AR mode, rotation is locked and the zoom is 1:1.

When the controller stick is beyond the upper threshold or below the lower threshold (or upon a specific user selection of VR mode), the headset transitions to VR mode, e.g., camera passthrough is deactivated and only the virtual objects are seen. Beyond the upper threshold, the user can receive a zoomed-in view, e.g., virtual objects can be viewed in detail. Below the lower threshold, the user can receive a zoomed-out view, e.g., the virtual objects can be viewed in their larger context.

In VR mode, rotation is enabled, such that virtual objects can be accurately viewed from a variety of angles and perspectives. Also, in VR mode, contextual tools, e.g., for annotation, object-modification, auditing, review, alignment, measurement, etc., are made available. The user can snap back from VR to AR (e.g., reactivate camera passthrough) by hitting a reset button or by moving the controller back to zero. When the user snaps back to AR, virtual objects snap back to their world-registered coordinates and camera passthrough is reactivated.

In this manner, the techniques of this disclosure enable simple, fast, and intuitive transitioning between AR and VR. An event planner, architect, engineer, gamer, or other user can envision their virtual object situated in the real world, and then, free of the distracting features of the real world, quickly transition to either a close examination or a landscape-perspective of the virtual object. The two views, AR and VR, are consistent in position, orientation, and scale. By reducing competing visual input and by controlled lighting, the described techniques result in a lower cognitive load for virtual-object manipulation tasks. The techniques enable users to virtually access hard-to-reach areas, manipulate virtual objects at both large scale and high precision, and generally get a better view. They represent a form of virtual locomotion and teleportation that enables changing of view and accurate rendering of perspective.

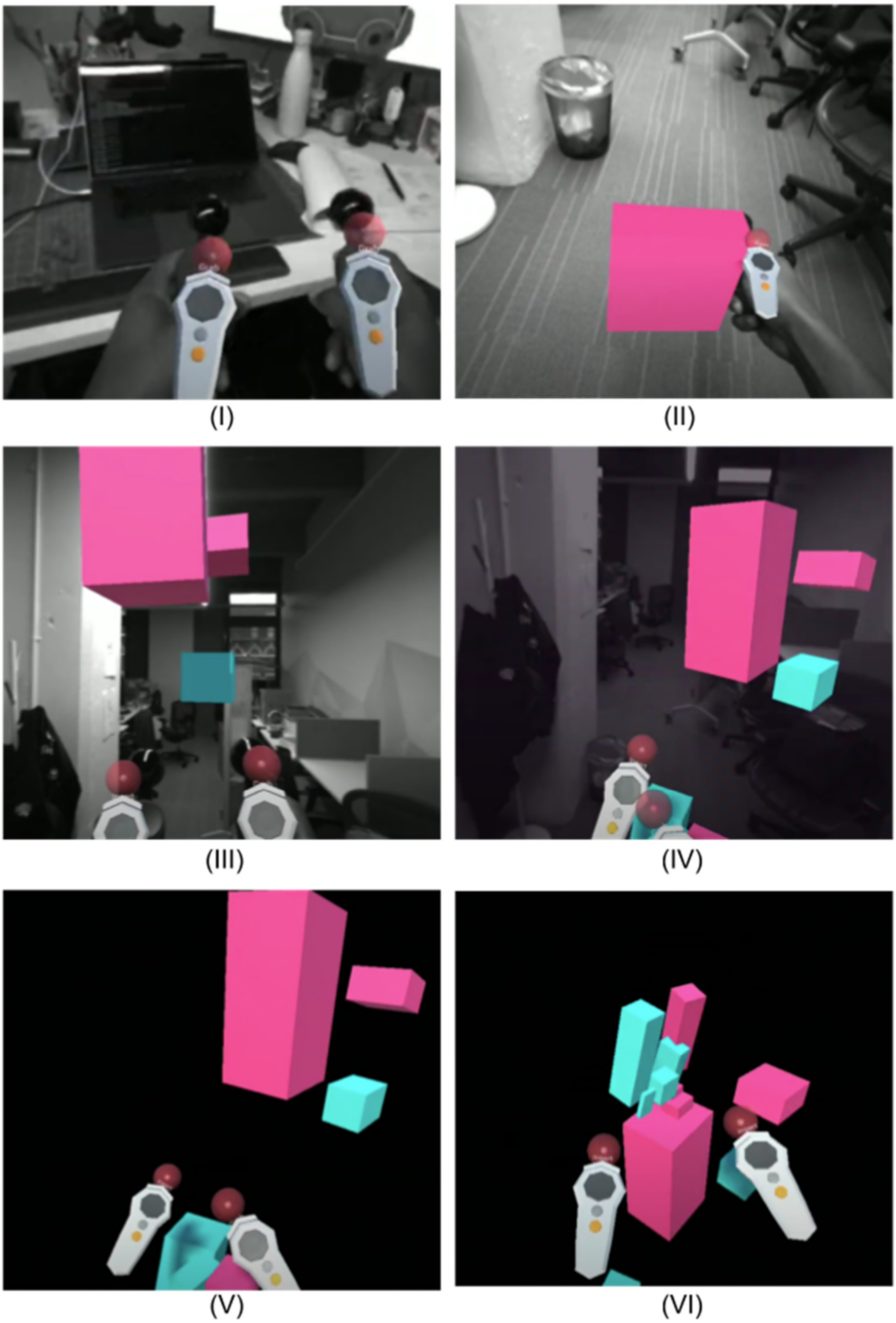


Fig. 2: Illustrating AR-to-VR transition and back

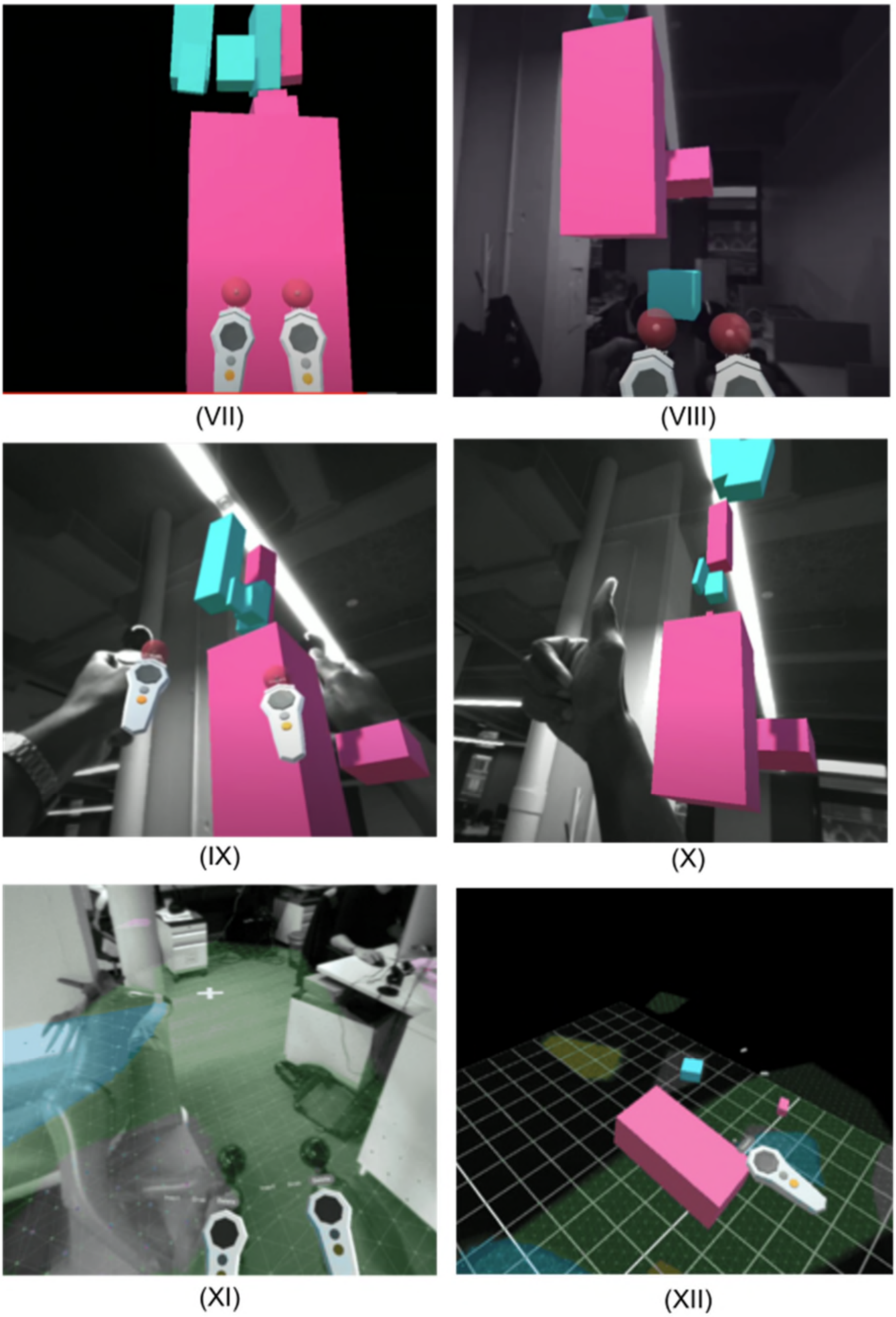


Fig. 2 (continued): Illustrating AR-to-VR transition and back

Fig. 2 illustrates consecutive snapshots of a video that demonstrate AR to VR transition and back. From the real world, the user grabs controllers, which reflect in AR in the form of avatars (I). Aside from enabling VR↔AR transitions, the controllers can also grab, create, modify, or move virtual objects, and otherwise respond to commands issued from contextual tools. Using a controller, the user creates a virtual object, the pink cuboid (II). Still within AR, the user creates more virtual objects, the pink and the blue cuboids (III). In AR, the coordinate system in use is that of the world (or scene).

The user transitions to VR using a zoom-out (IV). The user is fully in VR (V). In VR, the coordinate system in use is that of the object. The user further zooms out and examines a collection of virtual objects, without distracting features from the real world (VI). The central point of the scene around which zooming in or out takes place is indicated by user gestures, e.g., by moving the two controllers close towards the desired central point. The user rotates the object and zooms into it in VR mode (VII). The user transitions back to AR (VIII). The user is fully in AR (IX). In both AR and VR, depth-cueing is provided in various ways, e.g., by the casting of shadows of virtual objects on other (physical or virtual) objects, as shown in (IX). Satisfied, the user finishes the creation and installation of the virtual objects in real space (X).

Figures 2 (XI) and (XII) illustrate some features that guide the user. A grid pattern and cursor (the cross) can be used in AR to guide the user (XI). The grid plane survives the AR-VR transition and represents real, planar (horizontal, e.g., table; or vertical, e.g., wall) surfaces in VR (XII). In Fig. 2(XII), the two, small, white pills to the right-center are avatars of the user's real hands when viewed from a distant third-person view. They serve as user-location proxies. Similarly, anchors, world-space bounds, and other virtual features can be shown in both AR and VR views.

CONCLUSION

This disclosure describes techniques that enable a user to start in an augmented reality (AR) environment (where virtual objects can be observed in their physical surroundings) and move to a virtual reality (VR) environment (where virtual objects alone can be examined from various perspectives in detail or from a distance). The user can make the reverse VR-to-AR journey as well. The AR↔VR transitioning and the examination of objects from various perspectives is made possible by smooth transformations of scale and of rotation between the coordinates of the world (e.g., the scene) and the object.

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