

CHAPTER

8

COLLABORATIVE AR IN DIFFERENT DEVICE-BASED INTERACTIONS

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8.1 INTRODUCTION

Collaborative augmented reality (AR) is a multi-user interface that is embedded in an AR environment. It allows multiple users to share a virtual space projected into the common workspace (Billinghurst & Kato, 2002). Figure 8.1 shows the features of the collaborative AR interface. Virtuality is one of the important features of viewing and examining the virtual objects in the AR environment. Additionally, a collaborative AR interface requires augmentation to enhance real objects with virtual annotations. Multi-user is also a feature that has a collaborative AR interface for multiple users to gather in a room and perform cooperative work. Furthermore, independence is needed for a collaborative AR interface, so the users can have their independent viewpoint, which is called observation independence. The interaction can be dependent or independent in the collaborative AR environment according to the application's needs. Lastly, individuality is specified for the collaborative AR interface. Each observer can have different displayed objects in the shared workspace based on the functionality of

the application or the individual's option. This chapter is organized by firstly presenting collaborative AR tracking, and next it describes the collaborative AR types. Additionally, it introduces the concept of multi-user interaction for collaborative AR and discusses its implementation in various device-based interactions.

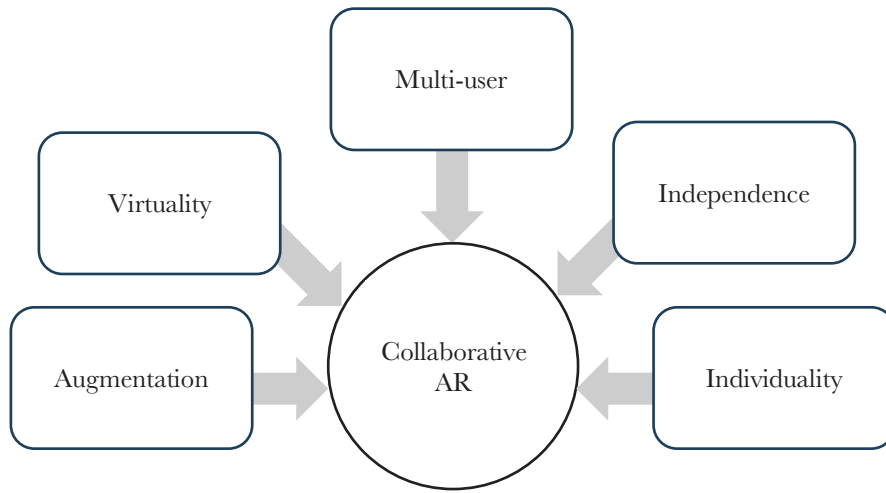


Figure 8.1 Features of collaborative augmented reality interface

8.2 COLLABORATIVE AUGMENTED REALITY TRACKING

Collaborative AR tracking is divided into two types, which are collaborative marker-based AR and markerless AR (Cheng et al., 2017). Collaborative marker-based AR is a form of AR where multiple users can interact with the virtual content that is anchored to physical markers in the real world only, while collaborative markerless AR implies that multiple users can interact with the virtual content without the marker.

8.2.1 Collaborative Marker-based Augmented Reality

Marker-based AR is always tied to a physical image pattern marker in the real world. The marker can be either a two-dimensional (2D) image or a natural object with visual features that are easy to extract in the real

environment. The marker used can be paper-based, called AR image recognition and tracking, or physical objects that exist in the real world. Marker-based AR means accessing digital content by detecting the marker, regardless of whether it is an image or an object.

For marker-based AR, the accuracy of tracking depends on the angle of view direction of the camera relative to the marker plane. The position, shape, and size of the display model rely on the information on the marker. The information on the marker can be acquired if the camera can track the marker (Boonbrahm et al., 2020). In other words, the collaborative marker-based AR enables users to see and interact with the same virtual objects if they have the same marker to trigger the same augmented reality process. The AR system ensures that the virtual object anchored to the marker is synchronized across all devices. This means that if one user moves or interacts with the virtual object, the changes are reflected in real-time for all other users who are viewing the same marker.

8.2.2 Collaborative Markerless Augmented Reality

Markerless AR is linked to the physical space around the device in the real world, and it does not rely on physical markers. Markerless AR depends on simultaneous localization and mapping (SLAM). It uses sensors and cameras to understand the environment by detecting surfaces, recognizing objects, and mapping out the space in real-time to place virtual objects in the real world. Then, it creates virtual anchor points in the environment to be tied to real-world locations, and they are used to keep the virtual object stable as users move around.

Collaborative markerless AR shares a consistent virtual understanding of the environment for the AR experience to be effective, so the users who are in the same environment can see and interact with the same virtual objects. The AR system synchronizes the spatial data and the position of virtual objects across all devices, ensuring that every user has a consistent experience. It needs to establish virtual anchors that are consistent across all devices. This ensures that every user sees the