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Co-Presence with Skeletons: A Multi-User Immersive Augmented Reality Demonstration in Cultural Heritage

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Figure 1: *Left: Two visitors being guided together by a virtual butterfly. Right: Two visitors collaborating on augmenting physical bones with virtual labels.*

Abstract

In this demonstration description, a prototype is presented that addresses the problem of isolation caused by single-user Augmented Reality (AR) applications used on cultural heritage (CH) sites. Using Microsoft's HoloLens 2 and Android smartphones, multiple visitors can experience the playful AR space together. Visitors follow a virtual guide together whereby authors can customize to how many users the system reacts, and engage in a labeling game in which visitors can collaboratively match Latin names and human bones to physical vertebrates' bones.

CCS Concepts

• ***Human-centered computing*** → *Mixed / augmented reality;* ***Collaborative interaction;*** *Interface design prototyping;*

1. Introduction

This is a description of a demonstration from the EU-project 'LoGaCulture', in which we tackle locative games in cultural heritage (CH). In this specific demo, the problem is addressed that while there exist Augmented Reality (AR) applications for CH using head-mounted devices (HMD), they mostly offer a single-user experience. This can lead to isolation as people often visit CH sites in groups. This demo follows the objective of a collaborative interactive immersive AR environment, using spatial augmentation of physical exhibits.

2. Related Work

So far, there are only a few AR multi-user applications in CH that focus on time-synchronous experiences [BS24]. Mostly they are aimed at visitor groups without experts or human guides. Often these experiences only run on handheld devices (HHD), less often on HMDs. To the author's knowledge, there are currently no cross-device experiences that use an AR HMD and an HHD.

Contribution. This prototype tries to close this gap by providing an AR cross-device multi-user application using immersive AR HMDs and HHDs to enable a social experience in a natural history museum.

3. Concept and Implementation

The presented demo has two parts that cover the two common visiting phases 'navigating' between exhibits and 'exploring' one exhibit [LSRD20]. This cross-platform prototype targets Micrsoft's HoloLens 2 and a recent Android smartphone, in this case a Sam-

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sung Galaxy S20+ as platform. The experience is synchronized in real-time between the users of all devices. The prototype was developed using the game engine Unity3D and Photon Unity Networking for real-time synchronization.

4. Description of the Prototype

4.1. Guiding

To support visitors in navigating the exhibition, the prototype employs a virtual butterfly that guides them from a designated starting point to an exhibit that features AR enhancements [BDL*22] (see Figs. 1, 2). In an initial authoring phase, the starting location can be positioned and a customized guiding path can be set by positioning virtual yellow columns (see Fig. 1). As these columns are an authoring device, they can be concealed from the users. When starting the experience, the butterfly awaits the users at the starting position. Once the guiding process has started, the butterfly will follow the pre-defined path to the exhibit.

The authors can choose who the butterfly should react to. If the visitors constitute a group of individuals with equivalent roles, such as friends or colleagues, it is possible to select that the butterfly only begins to fly after the entire group has reached the starting location. The progression of the guiding also depends on the collective actions of the entire group. An alternative option is that the butterfly reacts to a single user. Then, the guiding process is solely dependent on the actions of this user. For instance, this may be beneficial when a human guide has joined the group.

Figure 2: *Two visitors following the virtual butterfly. The yellow columns indicate the guiding path.*

4.2. Labeling game

The second part of the experience targets the homology between vertebrates' bones. It can therefore be conducted in a natural history museum, such as the one in Darmstadt, where an exhibit called "Skelettherde" (English: 'Skeletal Herd') is on display. This exhibit features skeletons from various vertebrates. With this AR prototype, visitors can learn together about the common bones of vertebrates. Visitors can match the Latin names of the bones to the physical bones using virtual labels (see Fig. 3). The system provides auditory and visual feedback if the label is placed correctly or not. Each user in the experience can select any label, allowing them to correct each other's labeling attempts and discuss while observing each other's labeling efforts. Additionally, visitors can compare human bones to those of other vertebrates. The prototype provides a virtual human skeleton that is consistent with the physical human skeleton in the exhibit. Visitors can select and place virtual bones on top of the physical bones of another vertebrate (see Fig. 3). Together, they can thus match all of the bones to another vertebrate.

Figure 3: *Top: Two visitors labelling a hyena's skeleton together. Bottom: Two visitors matching human bones to a vertebrate's skeleton. Picture taken from the HoloLens of the second visitor (indicated by the line at the bottom).*

5. Conclusion

In this work, a demonstration of a multi-user prototype in immersive AR for CH has been described. It allows multiple visitors to experience AR at certain exhibits together and interact with each other in the AR space.

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