Rapid prototyping approach for audio augmented reality user experiences

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ABSTRACT

Audio consumer devices, such as headphones, are increasingly supporting spatial audio. This opens opportunities for UX designers to explore the design domain of audio-only Augmented Reality (AAR) experiences. The paper documents a hands-on approach to prototyping audio AR with a combination of game engine software, headphones, and a smartphone. The approach was delivered at SIGGRAPH2021 in the Labs session format.

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1 THE DOMAIN OF AUDIO AUGMENTED REALITY (AAR)

Augmented reality (AR) is primarily perceived as a visual technology. Various AR applications leverage computer vision to understand the scene the user exists within. However, we experience audio spatially. While display technologies for all-day wearable light AR glasses repeatedly seem to be a few years away [Wagner 2019], the currently emerging spatial audio solutions open up opportunities for UX designers to explore the design domain of spatial and embodied, audio-only experiences.

Consequently, audio might play a more substantial part in how AR develops in short term. The emergence of spatial audio devices from Bose, Apple, and others is building on past research on audio AR headsets (e.g., [Tikander et al. 2008], [Gan et al. 2018]) and making spatial audio available to consumers. Research questions around audio AR human factors and user experience [Mariette 2013] are becoming more widespread for designers and creative technologists.

Besides the academic research that spans more than two decades, there have been recent public experiments relevant to the topic, especially in the creative realms. Collectives such as Darkfield in the UK have employed ambisonic audio for creating immersive experiences, both in location-based productions, and during the Covid-19 pandemic, for home consumption via the combination of a smartphone app used with headphones [Darkfield 2018]. UK-based creative studio Playlines created an audio-based AR experience using Bose's sunglasses and Bluetooth beacons into a nightclub setting [Playlines 2019], and BBC's R&D department has explored audio augmented reality experiences [BBC Research & Development 2020].

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2 PROTOTYPING AAR USER EXPERIENCES

These developments put the focus on the applications and content that spatial audio devices enable, rather than the technology itself. The approach to prototyping AAR experiences proposed here focuses on user experiences with headphones and smartphones that are accessible broadly. The approach aligns with more recent research on accessible audio AR solutions [Yang and Mattern 2019], [Yang et al. 2020].

Therefore, the prototyping approach caters for experiments where the user is in a specific mindset and role, whether this is a form of suspension of disbelief via engaging in a fictional audio AR experience [Jacuzzi 2018], similar to, e.g., the work by Darkfield mentioned above, or in a recreational or educational space that is designed to be interacted with or traversed in a certain way, such as a museum environment with an augmented audio guide or an audio-driven training scenario.

The approach does not claim to contribute to broader user experience considerations relevant to AAR, such as elegant hear-through solutions [Lindeman et al. 2007] which would allow for the user to distinguish the augmented audio from the sounds of the physical environment.

3 TOOLS AND LEARNING OBJECTIVES

The author's Labs session at SIGGRAPH2021 was designed to demonstrate how to begin practicing audio AR UX design through rapid prototyping.

The session consists of ideation around spatial audio experiences and rapidly experimenting them with the help of a tutorial project prepared for game engine software, in this case for Unity3D. The Unity project has been specifically designed for the purpose of enabling non-programmers to get hands-on with AAR. The format has been trialed in two iterations with test users and iterated based on the feedback.

The approach presents three learning objectives for the participants: 1) Understand the difference between binaural and spatial audio in practical terms, 2) discover a rapid prototyping approach to spatial audio, and 3) get started on creating a simple prototype of a room-scale AAR experience.

There are two different paths to facilitating ideation and experimentation with the Unity project: participants can start to experiment with the resources provided within the Unity project and the

'sandbox' for experimentation it affords, or, they can start developing an idea of a specific experience and then move on to creating a first iteration, testing it, and iterating further.

4 DESIGN SPACE AND WORKFLOW

The first stage of the workflow is about defining spatial boundaries for the experience. The Unity project is designed to enable a designer to reproduce the layout of a specific physical space. For this, they need rough measurements of the space. Having this information will enable a user to specify the boundaries of where the audio experience occurs and test it within the said space.

Once the layout is approximately reproduced in the Unity editor, the designer can start placing audio objects in it. In the project, the tutor has included a number of objects in the form of Unity prefabs that can be dragged to the scene view and thus positioned where they should emanate audio from. The objects have two key components: an audio source and a pre-defined behavior. When choosing an object to add to the space, the designer can choose the object with the behavior they need for their experience. For example, there are various objects with pre-defined movement in relation to the user or to the boundaries of the space, e.g. moving up or moving away from the user.

Once designers have placed and configured an object, they can import and attach it to the object's audio source. For example, if they want to create the impression of a person approaching the user, they can find or record the sound they want to object to make (in this case, a person). Designers can test the experience in the Unity editor at any point, using headphones. Once the designer has placed multiple audio objects into the scene, they make up a sequence that triggers one after another.

When a build is made for the phone, audio objects have 3D visual representations within Unity which allow for debugging the experience. The designer can evaluate the audio objects' positioning and how well their behaviors produce the desired result. This allows the designer to evaluate how the experience performs in the medium it will ultimately be distributed in.

5 FURTHER RESEARCH AND DEVELOPMENT

After SIGGRAPH2021, the author intends to deliver the workshop in other contexts to gather more feedback and requirements. The goal is to translate requests gathered into more objects and features in the Unity project. The project is available via GitHub: https://github.com/aquito/SpatialAudioARworkshop

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