AuSynthAR: A simple low-cost modular synthesizer based on Augmented Reality

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ABSTRACT

AuSynthAR is a digital instrument based on Augmented Reality (AR), which allows sound synthesis modules to create simple sound networks. It only requires a mobile device, a set of tokens, a sound output device and, optionally, a MIDI controller, which makes it an affordable instrument. An application running on the device generates the sounds and the graphical augmentations over the tokens.

Author Keywords

Augmented Reality, Sound Synthesis, Mobile Music

CCS Concepts

•Applied computing → Sound and music computing; •Human-centered computing → Mixed / augmented reality;

1. INTRODUCTION

In the field of music interfaces, Augmented Reality (AR) has been used for controlling synthesizer parameters on high expressive setups, making music through unusual objects and exploring new kinds of instruments [3] [5] [1].

The related work remarks the use of AR as an important and novel element to enrich experiences for digital instruments, like the *Reactable* [2], which is a successful example that uses AR to achieve high expressiveness and collaboration for creating interesting sound materials.

Some AR applications require expensive equipment [2] [1]; however, the computational power of mobile devices allow us to implement affordable AR tools. In previous work, such as in [4], an AR electrical circuit simulator was implemented and tested in a learning environment. In this proposal, the circuit simulator was replaced by a *Networked Modular Synthesizer*; hence, the *Audio Synthesis with Augmented Reality - AuSynthAR* was conceived.

This work describes *AuSynthAR* as a low-cost synthesizer based on AR for mobile devices, complemented with a *tangible user interface (TUI)* which consists of tokens and a plastic holder. Optionally, MIDI controllers can be added to the configuration. The synthesis approach is designed under the concept of a *modular synthesizer*.

Future directions for developing high expressive instruments are exposed, as well as opportunities to conduct tests in the musical and educational fields.

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2. SYSTEM DESIGN

2.1 Physical Space

The setup depicted in (Figure 1) shows the following relevant elements: A *mobile device*, where the audio synthesis engine and the augmented reality application are executed; a set of *tokens*, which are the fiducial markers that denotes sound modules; a *plastic holder* for the device, which allows the performer to interact with both hands; and, a *MIDI controller*, which enables the user to play musical notes and increase the possibilities for controlling the virtual modules. Speakers or any other sound output device can extend the physical setup.

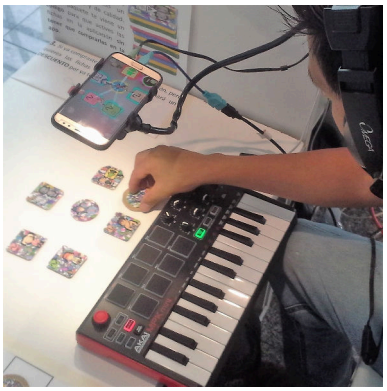

Figure 1: AuSynthAR physical setup.

The relationships among the hardware components are shown in (Figure 2). The *performer* interacts with the *tokens* and the *input devices*, which generate data that is processed by the mobile device. The *screen* acts as a visualizer since the actions are performed with the *fiducial markers*. The *built-in camera* allows the device to gather the input from the markers, and render the virtual augmentations that produce sounds through an output device, according to the internal synthesis engine.

2.2 Virtual Space

The virtual objects are the graphics and audio modules that support the generation of sounds due to the physical objects. The virtual space consists of the software components described in (Figure 3).

AuSynthAR is a real-time system that is feeding from two input sources: A *camera* and *external devices*. The data collected by the *camera* is managed through the *camera controller* and sent to an *image recognition process*, which identifies the *fiducial markers* and maps to the corresponding virtual object on each of them according to a strategy

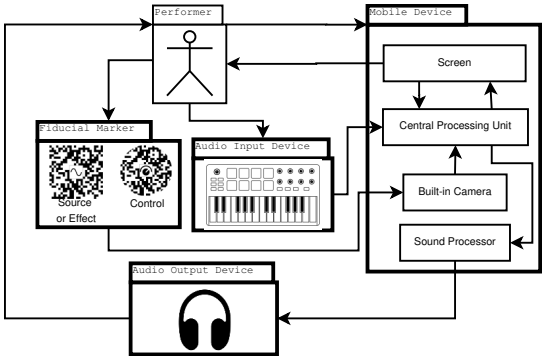

Figure 2: Hardware components for *AuSynthAR*.

denoted as the *coordinates mapping in virtual world*, which translates information from the real world to the virtual environment. Then, the graphics engine renders the 3D augmentations over the physical objects through the *3D objects and GUI rendering* module. Finally, the *synthesis engine* generates audio by using the *synthesis modules* according to the connections and manipulations given by the performer when using the markers; also, the system provides *graphical feedback* as well as *waves visualizations*.

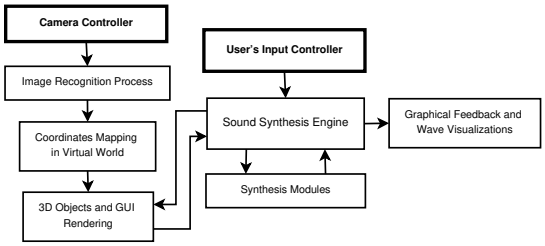

Figure 3: Software components for *AuSynthAR*.

The software application for this prototype was implemented in *Unity 3D Game Engine* and powered by the augmented reality framework *Vuforia*. The application was built for Android devices with MIDI support.

2.3 Sound Synthesis

Sound generation through the mobile device is achieved by making the calculations of the samples that are going to be played. *Unity* gives the possibility to procedurally build audio via the `OnAudioFilterRead` callback, which can manipulate the incoming audio buffer or generate new sounds, and fill a new buffer with the resulting samples. *AuSynthAR* calculates basic sound waves and operations, fills the new buffer with the samples and played them back.

An example of an interconnected sound synthesis network is displayed in (Figure 4), with 3D characters as a feedback for sound interactions. Each block represents a simple module that contributes to the final output.

2.4 Operational Process

Once the setup is assembled, the performer will be able to generate sounds and music by arranging the tokens (markers) physically and connecting them virtually. The connections can be established by approaching the tokens for an automatic connection, and then, separating them while a virtual wire appears between both. The circle-shaped tokens that act as "knobs", can be connected similarly; that is, when one token is connected to another, it can control a parameter, such as the amplitude or frequency, by rotating the virtual knob.

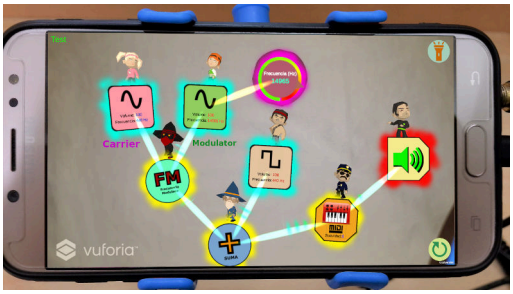

Figure 4: Sound synthesis network.

For hearing the resulting audio configuration, the performer needs to connect the last part of the chain to the *output* module. The network presented in (Figure 4) shows the described elements in a real-time operation.

3. CONCLUSIONS

This work presents *AuSynthAR*, a novel musical interface that uses augmented reality (AR) technology for modular sound synthesis with high accessibility. The proposed design establishes a physical setup as a combination of hardware and software components supported on mobile devices.

There is a high potential of this musical interface for novice music performers and learners regarding sound synthesis. Previous applications of AR denote the interest of users in manipulating physical and virtual elements for achieving their creative goals, while overcoming the challenges of connecting networks of components. The main contribution of this work is the construction of an affordable tool that can be installed and used easily by audio artists and people in general, to experience the block construction of sound and music.

For future work, human-interaction testing focused on expressiveness will be conducted to improve the design of this interface. Questionnaires and automatic logs are planning to be used. Also, an AR headset systems will be considered. Other assessments will also be taken into account, such as learning capabilities on academic courses related with sound synthesis.

4. ACKNOWLEDGMENTS

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