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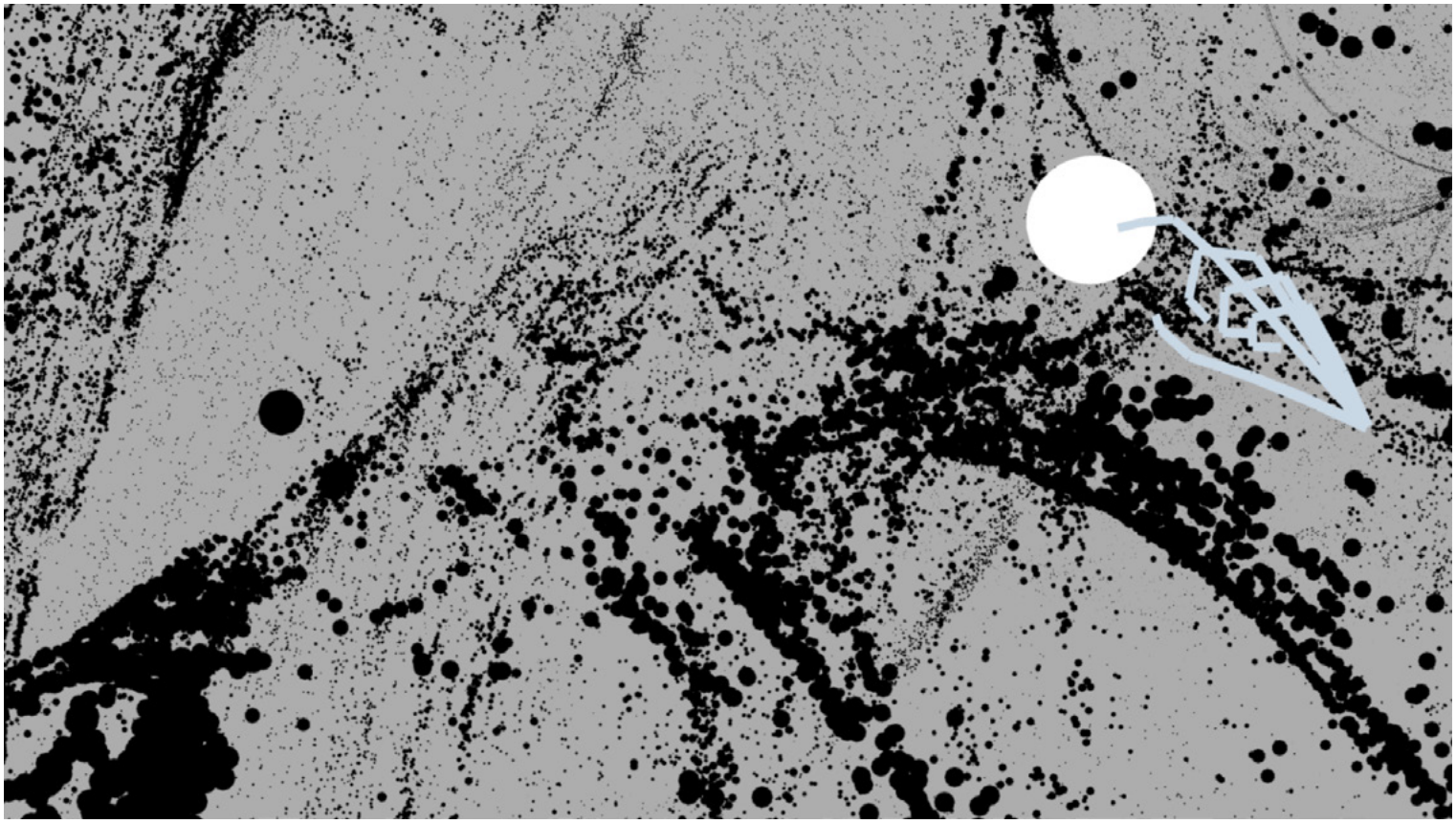

SIIIGNAL: An Electroacoustic Composition/Instrument in Virtual Reality

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SIIIGNAL is an electroacoustic composition/instrument in Virtual Reality (VR). The piece explores modes of interaction afforded by the VR environment; in combination with hand-tracking, gestural analysis and the physics engine of Unity3D, it provides a framework for musical expression using the VR medium. The player can instantiate sound particles in the space, perform sample triggering through collision detection, arrange sound objects in space, populate the environment with processing modules, spawn pulses that emanate spherically from the central sound object throughout the space triggering further sonic events, among others. The piece is divided into multiple sections with changing parameters over time and different rules. It starts requiring simple sonic gestures by the player, and as it progresses, emergent behaviours lead to more sonic complexity and possibilities for musical expression.

Keywords VR, Virtual Reality, Musical Game, Musical Expression, Immersive Audio

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Description

SIIIGNAL is an electroacoustic composition/instrument in Virtual Reality (VR). The piece takes advantage of the modes of interaction afforded by the VR space; in combination with gestural analysis and the physics engine of Unity[1], it attempts to shape affordances for musical expression true to the medium of VR. The aim of the composition/instrument is not to use modalities from common on screen-based instruments, such as step sequencers and synthesizers and recreate them in VR, but to give the freedom to the player to explore their own performance space and timings, informed by the piece's compositional vocabulary. The audio engine is designed and implemented in Pure Data[2], while the Enzien Audio Heavy compiler[3] was used to create native synthesis, audio playback and processing components for Unity.

The instrument consists of a library of samples arranged in VR space, with the player being able to interact with them in a number of ways:

The player can instantiate sound particles in the space, perform sample triggering through collision detection, arrange sound objects in space, populate the environment with processing modules, spawn pulses that emanate spherically from the central sound object throughout the space, triggering other actions. The piece is divided into multiple sections with changing parameters overtime and different rules.

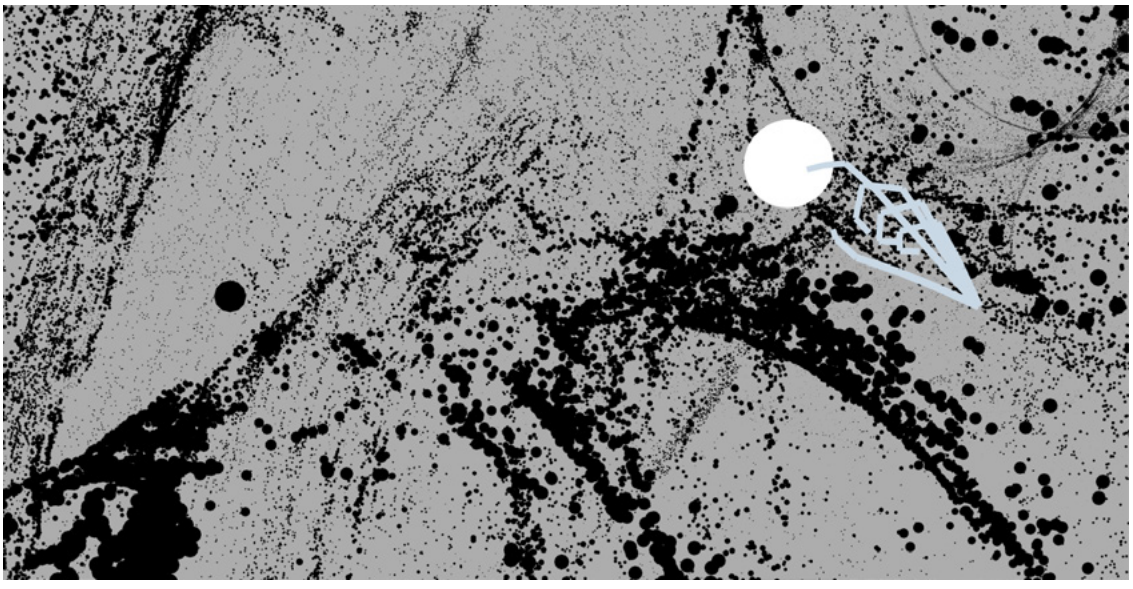

Fig. 1. *SIIIGNAL* Ingame still.

The player starts by performing simple sonic gestures, and as the piece progresses emergent behaviours can lead to more sonic complexity and possibilities for musical expression. The compositional aspect of the piece comes through evolving affordances: The piece's parameters and mechanics change over time, giving a sense of progression and continuity throughout its duration. The piece is divided into multiple segments, some of which progress linearly

1. https://unity.com/ (Accessed January 2022).

2. https://puredata.info/ (Accessed January 2022).

3. https://github.com/enzienaudio (Accessed January 2022).

based on time elapsed, while others require the user to perform certain actions, such as gestures, or interact with certain objects in a sequence. The sections are either blending into each other through parameter interpolation, slowly changing the attributes of the environments, or abruptly changing the environment after a section reaches a climax.

SIIIGNAL makes use of the physics engine of Unity3D. Depending on the section of the piece, for example, the attraction between individual sound particles changes. There are a few other objects in the scene where sound particles can collide. These emergent sonic behaviours lend themselves to increasing complexity, with the user interacting with the ongoing process on a higher level. In addition, each sound particle's audio is spatialised within the VR space making it possible for the user to experience the piece from different positions and move around the space in order to spawn and initialise interactions at different areas of the space, move away, which would make their sonic impact less audible on the overall soundscape according to the distance, and then return to further alter the sonic configurations if desired.

The hand-tracking functionality of the Oculus Quest is used for gestural analysis, which allows the user to intuitively instantiate and push objects in the VR space without the need to impose an extra layer of control through a physical interface such as a game controller. In order to gradually ease the player into the experience, the piece starts with very simple gesture requirements and sonic vocabulary, and as it progresses and the user becomes familiarised with the instrument's affordances, most of the required vocabulary is embodied and intuitively used. During non-timed sections, where the piece progression relies on the user completing certain goals, such as making specific objects collide, or touching objects for certain amounts of time, the user is free to explore all sonic possibilities that the space has to offer and spend as much time as they like. Some of the parameters used for audio control data include the specific fingers used and which fingers are touching each other performing different actions, as well as collision detection, L/R hand speed and acceleration and headset speed and acceleration. As an example, during a certain section, the headset's speed is mapped to the playback speed of samples, which leads to silence when the user is not moving their head. The game-time "freezes" and thus it is required from the user to move in order to progress the piece.

Fig. 2. *SIIIGNAL* Ingame still.

The samples include mostly segmented acoustic and minimal synthetic percussion sounds, with the processing areas including effects such as reverb, delay and filtering. In addition, granular, additive and subtractive synthesis techniques are used, with these being more closely mapped to real-time parameter control through gesture analysis. The physics-driven motion of objects and particles in VR space is directly mapped on sounds, giving to the user direct control over all aspects of the piece and all the different possibilities that it affords. As small changes between particles can cause larger changes on the soundscape overtime, the piece can take different directions on each playthrough depending on the intentions of the player, while maintaining the distinct attributes of each piece's section. In the same way that an improviser can perform a particular type of sonority on their instrument, while never being exactly the same, this piece allows the player to be expressive within the limits of the musical vocabulary of each section.

The piece follows a series of game-structured musical performance pieces such as *Pathfinder* (Michalakos 2016), *ICARUS* (Michalakos 2019) and *Death Ground* (Michalakos and Wærstad 2019). Some of the background and design process is documented on the composer's article *Designing Musical Games for Electroacoustic Improvisation* (Michalakos 2021).

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