The Composition of Interactions in 'Guerreira das Pedras' (2024)

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ABSTRACT

This work presents the creative and compositional processes in the piece Guerreira das Pedras (2024) for saxophone, dance, video, and real-time electronics. In this paper, we prioritize an emphasis on the conceptual aspect, where we discuss the main artistic intentions and how the poetics of the piece influenced the choice of tools in the creative workflow involving interactive and multimodal systems. The text presents the artistic motivations, a description of processes and interconnections, a description of the computational model, as well as reflections on the relationship between aesthetic intentions and technological choices. Part of the methodology presented is inspired by the proposal of composer and researcher Marije Baalman, where some visual symbols were also used to exemplify the workflows and procedures carried out.

1. INTRODUCTION

This text presents the compositional steps and strategies employed in "Guerreira das Pedras" (2024) for saxophone, video, dance, and real-time electronics. Premiered in 2024, the piece was part of the *Imaginários Sonoros* group, associated with the "Composition and Performance Atelier in Music and Interactive Art" discipline, offered within the "Espaço de Criação e Investigação Sonora" [1] (ECrIS) at the Centro de Pesquisa em Música Contemporânea (CPMC) [2], a complementary department of the UFMG [3] School of Music. In this collaborative space, participants are encouraged to develop creative proposals based on a project-centered approach [1]. Both musical direction and teaching activities were led by professors Dr. José Hen- rique Padovani and Dr. Rogério Vasconcelos.

The piece aims to foster listening and perception experiences of frequently ignored or unsought sounds of the saxophone, such as breath sounds and key clicks. The butterfly's metamorphosis serves as a poetic allegory, as well as its sudden appearance and movements mirroring the emergence of these understated yet expressive sonic elements.

This is achieved through the exploration of real-time audio processing, spatialization techniques, motion capture processes, and interactive visual elements. The piece's electronics was developed in *SuperCollider* [4], utilizing *FluCoMa* [5] and IEM Plugin Suite for the *Ambisonics*-based spatialization and sound diffusion. For the creation of the interactive video projection and the capture of the dancer's movements, the piece utilizes *openFrameworks* [6] and *MediaPipe* [7], respectively.

The paper structure is outlined according to some guidelines, methodological steps, and concepts proposed by Baalman [2, 3]. Briefly, it consists in answering some questions about the creative project regarding: the motivations of the composition, who was involved in the project, which were the composition/performance contexts, and what was the creative approach to compose/perform the piece.

2. GUERREIRA DAS PEDRAS

2.1 Artistic Motivations

Butterflies are notable for their many intriguing features. They undergo metamorphosis, drink other animals tears [4], are important for pollinating flowers, but are also associated with various folk beliefs such as being the souls of the dead or foreshadowing death. Moreover, they possess a gracefulness that simultaneously preserves an intimacy and secrecy. They are beings that often go unnoticed, after all, we cannot hear them.

A unique species inspired the creative project presented in this paper. *Agojie Rupícola*, commonly known as the *Guerreira das Pedras* ("Stone Warrior"). Recently cataloged in the eastern part of Minas Gerais state, Brazil, it has a woody color that allows it to camouflage with the rocks characteristic of its habitat. Unfortunately, *Agojie Rupícola* is already endangered, like many other species[5].

How can we express these characteristics non-literally through interactive audio, dance, and video in a multimodal project? To address this, we drew inspiration from a literary image. In Gabriel García Márquez's *One Hundred Years of Solitude*[6], the character Mauricio Babilonia is

[1] Creative and Sound Investigation Space
[2] Center for Research in Contemporary Music
[3] Universidade Federal de Minas Gerais - UFMG (Federal University of Minas Gerais)

[4] Audio synthesis and algorithmic composition platform developed by James McCartney in 1996.
[5] Project Fluid Corpus Manipulation. Available in:: ¡https://www.*FluCoMa*.org/¿. Accessed May 28, 2024.
[6] Open-source tool designed for programming multimedia applications involving audio, video, and image analysis. It is written in C++ and implemented using the Khronos Group's OpenGL API.
[7] Google's open-source platform for building Machine Learning pipelines capable of processing, analyzing, and extracting information from media. Open-source platform maintained by Google for creating Machine Learning pipelines to process, analyze, and extract information from media.

Figure 1. *Agojie Rupícola*. **Source**: https://www.mapress.com/zt/article/view/zootaxa.5346.1.5

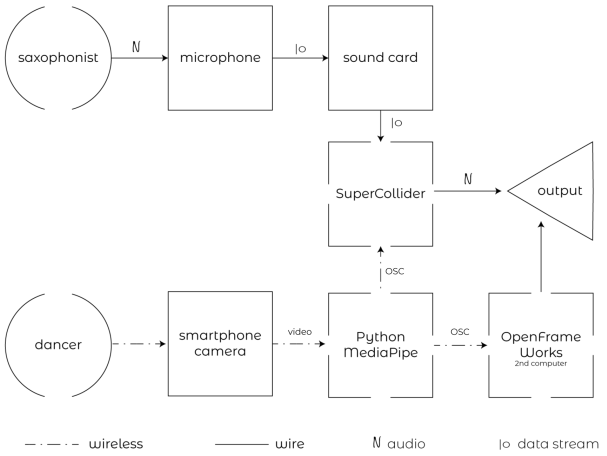

Figure 2. Processes and Interconnections

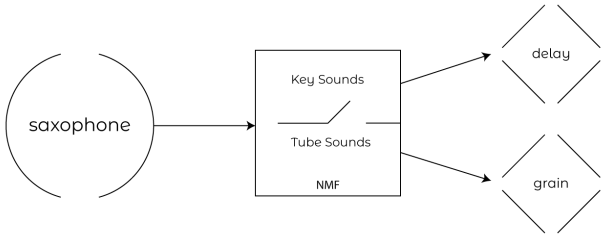

Figure 3. Source separation

perpetually surrounded by an aura of butterflies, a visual marker of his presence. Mirroring this, we chose to project interactive grains around a dancer, symbolizing this ethereal aura. These grains, like butterflies, would appear and disappear almost imperceptibly, creating a fleeting visual experience. In the sonic realm, we isolated the key-clicking sounds produced by the saxophone's mechanism, extracting them from their usual musical context. Often dismissed as noise, these sounds possess unique qualities that can be integrated into a musical composition, adding another layer of non-literal representation to the project.

To realize this poetic vision in a real-time performance, we explore computational models and methods for interconnecting instruments. The following sections detail how these technical elements were implemented and interwoven to translate our artistic ideas into an interactive experience.

2.2 Processes and Interconnections

The piece's performance is centered around the dancer's movement, which simultaneously modulates sound and visual processes. The musical form is structured around guided improvisation, with specific sonic gestures from the saxophone and visual gestures from the dancer defining sections and triggering new events – musical, dance-related, or video-based.

Generally speaking, the map of connections and signal information follows the diagram of Figure 2: the saxophone is processed by *FluCoMa* in *SuperCollider* where the sound is divided into two distinct channels: the sound of the keys with delay and granulation effects, and other saxophone sounds with only reverb (Fig. 3). At the same time, a smartphone is used as a wireless video camera. The video stream is sent to the computer where the movement of the dancer's hands are detected by means of computer vision tools (MediaPipe). The movement coordinates are sent through OSC (Open Sound Control) messages to an appication created using *openFrameworks*, where the moving images is generated in real time, and to *SuperCollider*, where they are used to control audio processes such as the *Ambisonics* spatialization.

A tablet interface was created, using the *TouchOSC* [8] , to trigger both the granulator and granulation freeze in *SuperCollider* at various points during the piece. Since the performer playing the saxophone also controls the electronics, MIDI pedals are also used to control the electronics.

2.3 Computational Model

Three distinct programming platforms were employed for the realization of this piece: *SuperCollider* for audio processing, *openFrameworks* for video, and *Python* (with packages *MediaPipe* and *Python OSC*) for capturing the dancer's hand movements parameters and send them through OSC messages to control both the video and certain sound parameters. *Ambisonics* techniques are used to spatialize and decode the audio signals to an octaphonic setup, using the *IEM Plug-in Suite* [9] .

2.4 Music and Audio

Within *SuperCollider*, we utilized the library from the *FluCoMa*.org project, specifically the `BufNM` object, to perform a sound decomposition of the saxophone. This decomposition allowed us to separate the sound of the keys from the other sounds produced by the instrument. Ac-

[8] TouchOSC is a modular control surface toolkit for designing and constructing custom controllers that can be used on a multitude of operating systems and devices

[9] The IEM (Institute of Electronic Music and Acoustics) Plug-in Suite is a free and Open-Source audio plugin suite including Ambisonic plug-ins up to 7th order created by staff and students. Available in::¡https://plugins.iem.at/¿. Accessed May 28, 2024.

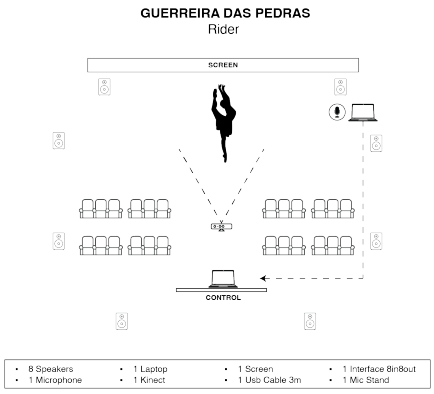

Figure 4. Technical Rider

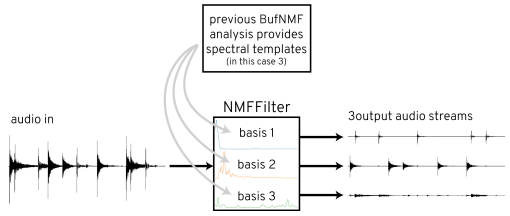

Figure 5. FluCoMa's NMFFilter decomposition process. **Source**: `https://learn.flucoma.org/reference/nmffilter/`

cording to the project's documentation [10] , `BufNM` employs non-negative matrix factorization (NMF) [11] to decompose the magnitudes of a spectrogram into a user-specified number of components. After several analysis tests, the use of three components proved to be sufficient for separating key clicks and similar noises. Each component is represented by the combination of two elements: a spectral template (basis) and an amplitude envelope (activation) that are stored in buffers (Fig. 5). Activations and bases can be used in various ways, either for the resynthesis of the decomposed audio or for training and decomposition of audios different from the source used as a dataset. Following training/analysis, the playback process proceeds using the `FluidNMFFilter` object. This object divides the signal into distinct audio channels based on the set of spectral templates provided by the `BufNMF` analysis. Non-negative matrix factorization is applied to a single spectral frame, utilizing the previously provided and stored bases in the buffers.

For the training process, the strategy we have used was to produce saxophone recording with a great amount of key clicks/noises while also having, simultaneously, tube sounds. This allowed us to apply separate effects processing exclusively to the key sounds of the instrument. The additional effects included granulators and delays, which were modulated by OSC messages received from the Python / MediaPipe / Python-osc server.

The piece used *Ambisonics* spatialization for eight channels, realized via the *IEM Plug-in Suite*. The delays and grains produced by the saxophone key sounds were randomized across the speakers around the room, while the saxophone tube sound remained fixed in stereo format on the speakers next to the stage. Our intention was to reproduce for the audience the idea of butterflies flying around Mauricio Babilonia's head in *One Hundred Years of Solitude*[6].

[10] Available in::¡ https://learn.*FluCoMa*.org/reference/bufnmf/¿. Accessed May 28, 2024

[11] (LEE; SEUNG, 1999)[7] and (BROWN; SMARAGDIS, 2003)[8].

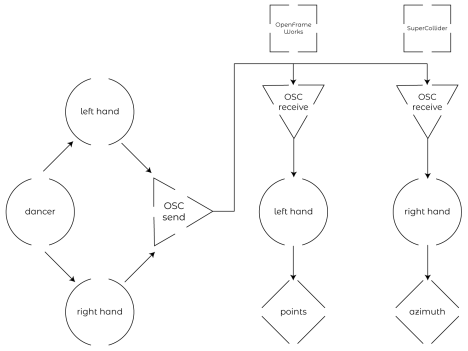

Figure 6. MediaPipe / python-osc communications

2.5 Dance

The *MediaPipe/Python OSC* server enables to process the received video stream and retrieve parameters related to the dancer's hand movements (Fig. 6). These parameters are explored to control both the effects within *SuperCollider* and the directions of grains rendered in the *openFrameworks* application. The coordinate data are mapped to control certain delay parameters and the `azimuth` of the *Ambisonics* system via the *IEM Plug-in Suite* `VSTplugin`. Furthermore,*MediaPipe*'s finger detection is used to differentiate between open and closed hand positions, an information that is explored in *SuperCollider* to activate or deactivate the 'freeze' parameter of a granulator

2.6 Video

For video production, we focused on generating grains that responded to the dancer's hand movements. Within the application for this purpose, programmed in C++/ *openFrameworks*, the frame updating function works as follows: the application receives OSC messages and processes them to obtain coordinates, specifically those associated with the addresses `/xright` and `/yright`. The received coordinates are used to create a point (`handRightPoint handLeftPoint`), which is then added to the list of points (`points`). The position of the points is adjusted, and the center of the line is recalculated based on the average of the point positions. The `polyline` technique is used to smooth the drawing motion in the video. In the `Draw` function, a mesh (`mesh`) is created to draw a ribbon connecting the points. This ribbon is drawn based on the direction and distance between the points, with varying line thickness to create a brushstroke-like visual effect. The mesh is drawn using `mesh.draw()`.

2.7 Aesthetic intentions and technological resources

In the field of composition with interactive systems, the possibilities of tools are so diverse that it's easy to get distracted from the outcome and lose sight of the poetic and artistic meaning we're engaged in. The issue is that art requires an intention that is not merely a demonstration of techniques and technological devices and how incredible they can be at performing tasks that are more difficult for humans. By defining an aesthetic and a meaning beforehand for the piece, we are forced to limit a range of alternatives that would make it possible to realize this imagined and abstract "dream" that we have decided to communicate through art.

The poetic idea of *Guerreira das Pedras* revolved around giving voice to the underappreciated sounds of the saxophone and relating them to the aura of grains, as if they were butterflies. The initial technological challenge was to isolate and process the sounds of the keys as if they were separate instruments. The feasibility of the piece's core aesthetic was contingent on the success of real-time processing using the *FluCoMa* library. This is a common issue in the planning phase of interactive artistic compositions: a period of experimentation is necessary to assess the capabilities of computational resources and determine if they can achieve the desired artistic outcome. The musical form of the piece, for instance, was developed only after the completion of the *SuperCollider* code.

Following the sound composition process, we began exploring options for video processing software. We have decided to explore C++/ *openFrameworks* due to its efficient processing and free accessibility. Finally, the decision to use Python*MediaPipepython-osc* for hand tracking was driven by the tight deadline for the piece's premiere. The pre-trained algorithms offered a reliable solution for creating an interaction between the dancer, video and music.

It's clear that the choice of technological tools is also linked to the artist's expertise, especially when we consider the deadline for completing the piece or performance. Is there time to learn a new set of tools? Is there a reasonable deadline for creating a more elaborate algorithm or artifact? All of these questions need to be evaluated during planning, but they are constantly subject to change throughout the project. Something that was foreseen and didn't work as planned can alter the aesthetic intentions or even make the initial idea unfeasible.

3. CONCLUSIONS

In this paper we have presented the creative and compositional processes within a multimodal composition involving instrument, dance and an audiovisual system. It explores Marije Ballman's methodological model to present these processes, emphasizing a conceptual approach over a focus on rapidly changing technical specifics. We highlight how poetic and allegorial elements may have a crucial role in guiding the production, development, and experimentation stages, helping artists using interactive means to filter and refine the vast array of computational possibilities.

Creating works involving interactive systems increasingly requires interdisciplinary expertise, with artists often navigating this intersection of knowledge even when collaborating with specialized professionals, as demonstrated in the by the composition/performance of *Guerreira das Pedras* and in other artistic projects held by *imaginários sonoros* [1]. If the diverse open-source technological tools employed were as relevant as the ideas and poetic allegories that motivated this project's composition – alongside the theoretical and conceptual elaborations of Baalman and other authors focused on the specifics of creation involving interactive systems – we hope that the account of the experiences presented here can contribute as possible approaches for other artists and researchers.

Acknowledgments

We would like to express our sincere gratitude for the support provided by CNPq, FAPEMIG, the School of Music at the Federal University of Minas Gerais (UFMG), and the Federal Institute of Rondônia (IFRO). We are also grateful to the dancer Serena Rocha for her professionalism and valuable contributions to the performance's aesthetics.

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