[°poly°] - A Distributed and Interactive Sound Installation Based on Tangible Autonomous Agents

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***Abstract*—This paper presents [°poly°], a generative and interactive music installation based on networked, tangible and semi-autonomous modules. After a presentation of the research objectives and inspirations, the paper describes the hardware and software implementation, and finally reports on the main compositional aspects. A video presentation is available at https://youtu.be/6azZ5_TcmkE.**

I. Introduction

[°poly°] is a generative and interactive music installation based on networked, tangible and semi-autonomous modules (website: http://b-ma.fr/poly/, video: https://youtu.be/6azZ5_TcmkE). The installation was created at the *Reservoir Festival* (https://reservoir.space/), Germany, in July 2019 (cf. Fig. 1, right) and also presented during the *Studio 5 en direct* day at Ircam in December 2019 (https://www.ircam.fr/agenda/studio-5-en-direct-6/detail/).

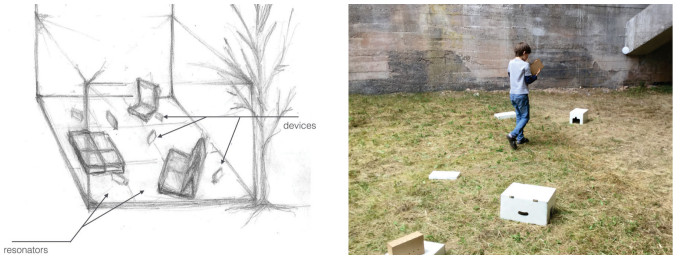

Fig. 1. On the left: first sketch of [°poly°], 2017. On the right: first public presentation at the Reservoir Festival, Germany, 2019.

The main idea of the installation, initiated in 2017 (cf. Fig. 1, left) is to propose a tangible space composed of resonant elements that the public can activate and explore by freely manipulating and displace musical and sonic modules equipped with a surface transducer. Thereby, the goal is to create a space shared by both the tangible autonomous agents and the public, where they can loosely interact while keeping their own temporality and autonomy, or so to speak, *cohabit*.

In the remainder of this paper we present first our research objectives (Section II) and works that have inspired [°poly°] (Section III), then we describe the hardware and software implementation (Section IV and V) and the main compositional aspects (Section VI).

II. Research Objectives

The development of [°poly°] has been inscribed in a more general research dedicated to the development of a Web based experimental platform dedicated to distributed music systems [1]. More precisely, the project aimed at creating a playground [2] to experiment with conceptual, technological and artistic ideas in order to: 1. re-question and extend our technological and conceptual framework centered on mobile devices [3]–[5], 2. propose an artistic perspective reconsidering current *ubiquitous computing* approaches [6] and on the integration of the environment in the process of interaction [7], and 3. promote the idea of *bricolage* and, *hacker* and *maker* approaches as important aspects of the learning and research processes.

III. Inspirations

Among the works that inspired [°poly°], two of them appear particularly important.

The *ondes Martenot* and more precisely the speakers of the instrument–called *diffuseurs*–provided us the idea of interleaving digital and tangible spaces at the synthesis level itself, an approach that still appears under-explored in the design of electroacoustic systems.

The *musicBottles* installation by Ichii et al. [8], and more generally the HCI paradigm of *Tangible User Interfaces*, constituted an inspiration for the radically simple interaction modality proposed by the installation: *taking something and putting it elsewhere*.

IV. Hardware Implementation

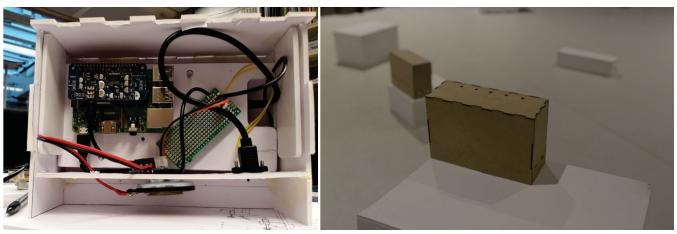

Fig. 2. On the left: first prototype of the modules realized using cardboard. On the left: final modules and cardboard *diffuseurs*.

Modules were built using consumer grade hardware and common connectors to minimize maintenance and simplify

evolutions [3]. They are composed of a Raspberry Pi 3 model B+, a stereo soundcard, a class D amplifier of 2.1W, a surface transducer and a 10000mAh battery.

After a prototyping phase to validate the design using cardboard (cf. Fig. 2, left), final boxes have been made using lazer-cutted 3mm Medium-density fiberboard and 3d printed pieces for internal components. The *diffuseurs* have been realized using simple white-painted cardboards (cf. Fig. 2, right), allowing to desacralize the installation and to encourage the audience to playfully manipulate it.

V. Software Implementation

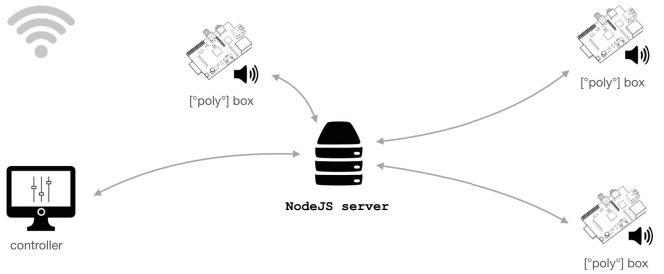

Fig. 3. High-level architecture of `[°poly°]`.

The software system was developed using `soundworks` (https://collective-soundworks.github.io/), a full-stack JavaScript framework for the development of distributed WebAudio and multimedia applications [5]. As illustrated in Fig. 3, each module runs a *Node.js* (http://nodejs.org/) client connected to a *Node.js* server through WiFi. A dedicated Web interface allows for monitoring and controlling the application from a centralized position.

Audio synthesis is achieved using `node-libpd` (https://github.com/ircam-jstools/node-libpd), a *Libpd* [9] binding for *Node.js*. The library enables the instantiation and orchestration of *PureData* patches directly inside the JavaScript code.

VI. Compositional Aspects

In compositional terms, `[°poly°]` can be described as a generative system based on algorithmically generated rhythmical and polymetrical patterns–using techniques inspired by G. Ligeti and early american minimalists–from which emerges a counterpoint of evolving melodico-rhythmic structures.

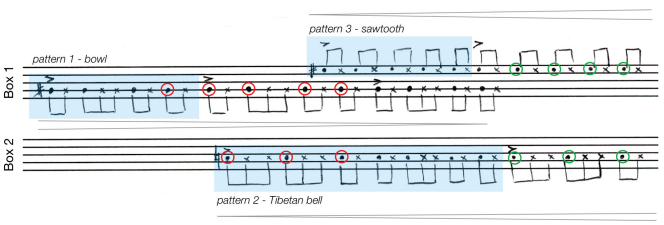

Fig. 4. Score of a possible result of the generative processes. Green and red circles highlight melodico-rhythmic structures that can emerge between several patterns.

The modules are synchronized on a common pulse of 200ms and generate patterns mainly defined by three dimensions: a rhythmic sequence inspired by *aksak* rhythms, a pitch randomly picked on a blurred modal scale, and a soundbank of recorded percussions (e.g. bells, bowls) or simple synthesized sounds (e.g. sine, square). Each pattern is finally modulated through an envelope that gradually makes it appear and disappear for a total duration varying between 45 and 75 seconds. These different aspects allow for creating a dynamic network of spatially distributed melodico-rhythmic cells that emerge from the layering and the interleaving of the different patterns (see Fig. 4).

VII. Discussion and Future Works

This project has offered an interesting playground to test, implement and refine ideas that led to the implementation of several software libraries, tools and to the novel version of our framework `soundworks`. Concerning hardware, the modules described here provided an important milestone in the design and implementation of a more generic device, that could support a wider range of artistic and research practices. In the two public presentations, informal discussions showed that the installation has been generally positively received by the public.

Acknowledgment

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