Sunflower: An Interactive Artistic Environment based on IoMusT Concepts

Rômulo Augusto Vieira Costa
romulo_vieira@midiacom.uff.br
MídiaCom Lab, Fluminense Federal University
Niterói, RJ, Brazil

Débora C. Muchaluat-Saade
debora@midiacom.uff.br
MídiaCom Lab, Fluminense Federal University
Niterói, RJ, Brazil

Flávio Schiavoni
fls@ufsj.edu.br
Computer Science Department, Federal University of São João del-Rei
São João del-Rei, RJ, Brazil

ABSTRACT

The Internet of Musical Things (IoMusT) is an interdisciplinary area that aims to improve the relationship between musicians and their peers, as well as between musicians and audience members, creating new forms of interaction in concerts, studio productions, and music learning. Although emerging, this field already faces some challenges, such as lack of privacy and security, and mainly, lack of standardization and interoperability between its devices. Therefore, an environment design, called Sunflower, was proposed, which tries to contribute to solving the most recurrent problems in this area, specifying an architecture pattern, protocol, and sound features that aim to allow heterogeneity in these systems. Its practical implementation resulted in an interoperable, multimedia, and interactive environment. This paper, therefore, shows a demonstration of how Sunflower works in the accomplishment of an artistic presentation, also emphasizing its approach, the technologies that support it, and the advances it can bring to the area of IoMusT.

CCS CONCEPTS

• **Networks → Network experimentation**; • **Applied computing → Media arts**.

KEYWORDS

Internet of Musical Things, Sunflower, Environment design, Network Music Performance

ACM Reference Format:

Rômulo Augusto Vieira Costa, Débora C. Muchaluat-Saade, and Flávio Schiavoni. 2022. Sunflower: An Interactive Artistic Environment based on IoMusT Concepts. In *ACM International Conference on Interactive Media Experiences (IMX '22), June 22–24, 2022, Aveiro, JB, Portugal.* ACM, New York, NY, USA, 3 pages. https://doi.org/10.1145/3505284.3532818

1 INTRODUCTION

Musical practice is an activity inherent to human culture, permeating it since its beginnings. This art has also always been susceptible to the technological changes that have accompanied each era, especially with regard to the methods of sound recording and reproduction. It can be divided into four distinct generations [1, 5]. The first one is the "Acoustic Age" (1877 - 1925), characterized by the exclusive use of mechanical devices. Then, came the "Electric Age" (1925 - 1945), from the extensive use of electricity, allowed the emergence of equipment such as microphones, amplifiers, and recorders. After World War II, magnetic tapes began to be used for audio recording, launching the "Magnetic Age" (1945 - 1975). At long last came the "Digital Age", which began in 1975 and continues today. This era changed the way music is consumed by replacing analog sound with digital encoding. The emergence of the Compact Disc (CD) represented the beginning of this digitalization, but the most considerable transformation was the emergence of the MP3 file format, which quickly became popular and eliminated the need for physical media to hold audio files.

With regard to technological advances, the dissemination and cheapening of broadband Internet, data storage media, and electronic products culminate in the emergence of the Internet of Things (IoT), whose basic concept deals with the widespread presence of a variety of objects in everyday life, which, through unique addresses, are able to interact with each other and cooperate with their neighbors to achieve common goals.

This was also reflected in artistic practice since by expanding the concepts of IoT to music, a new area of interest called the Internet of Musical Things (IoMusT) arise. It is characterized by being multidisciplinary, encompassing concepts from ubiquitous music [4], mobile music [3], artificial intelligence [2], human-computer interaction [6], and other fields of computer science and music. It is formally defined as a set of interfaces, protocols, and pieces of information related to music, which enable services and applications with an artistic purpose from interactions between humans and musical things or between these same musical things in physical and/or digital media [8].

The aforementioned musical things are a new class of devices predicted by IoMusT. These gadgets are capable of acquiring, processing, performing, or exchanging data that serve a musical purpose. The combination of artifacts capable of connecting to the network with services and applications of a musical nature creates an interoperable environment, responsible for interconnecting musicians, instruments, and audience members, which multiplies the possibilities of interaction in art shows, creates a relationship of interdependence between elements involved and facilitates smart studio production and music e-learning [7].

Despite being an area with great artistic and computational potential, IoMusT lacks standardization in its environments. As a result, some work has emerged to tackle this problem. However, they are fragmented, focusing mostly on how communication takes place over the network and how the structures of musical things

IMX '22, June 22–24, 2022, Aveiro, JB, Portugal

ACM ISBN 978-1-4503-9212-9/22/06.
https://doi.org/10.1145/3505284.3532818

are, leaving aside a discussion about the high-level control of these devices. In addition, most environments use concepts and technologies that follow the preferences of their developers, not allowing them to be adapted to the most varied usage scenarios.

All these difficulties motivated the elaboration of an environment design, called Sunflower [10], which presents a workflow based on the Pipes-and-Filters architecture and aims to mitigate the interoperability issues in this area. This leads up to the creation of more than 30 musical things that enrich the environment with their audiovisual aspects. Furthermore, the entire system is interoperable and participatory, allowing the connection of devices that operate with different data types and protocols, capable of changing, in real-time, the audio and video settings. In this sense, the present paper shows a demonstration of how Sunflower works in the accomplishment of an artistic presentation, also emphasizing its approach, the technologies that support it, and the advances it can bring to the area of IoMusT.

The remainder of this paper is structured as follows. Section 2 presents the main features of Sunflower, focusing on essential aspects for an artistic performance mediated by the network and on the behavior of musical things. Section 3 shows its practical implementation, the development of musical things and the technologies behind it, as well as the novelties proposed by the work and how it will be exhibited in the conference. Finally, Section 4 presents summarized conclusions on the completion of this work.

2 ENVIRONMENT DESIGN

Sunflower can support countless musical instruments and things that exchange information over a network, providing an interactive experience completely based on the precepts of the Internet of Musical Things.

As there are few examples of IoMusT environments, it is difficult to reach a consensus on which features are desirable for them. In such a way, the authors made use of definitions offered by the areas that permeate this field, such as networked musical performance, interactive art, and ubiquitous music [8]. Added to this, there are their empirical experiences when working with music over network and interactive performances for the last 12 years.

Therefore, we consider that a network infrastructure for artistic-musical presentations must present some general properties, such as low latency, interoperability, and scalability. Besides, there are concepts derived from network musical performance, such as easy integration and user participation, ideas derived from interactive art, such as integration with different data types, and precepts from ubiquitous music, such as the ability to reconfigure and independent implementation of the tools chosen by the developers.

Likewise, there are specific requirements for each system. In the case of Sunflower, it must also be qualified to handle different pieces of information, such as audio, video and control, expanding the capacity of non-musicians to participate and assist in an artistic creative process. Due to the difficulty of meeting these requirements in a real system, the environment presented here focuses on offering the first three features aforementioned. Of the desirable features for the devices, the following stand out: heterogeneity and transparency, exchanging control information, input and output information, and integration with legacy software/hardware [9].

3 PRACTICAL IMPLEMENTATION

Based on the structure and protocols that govern the operation of Sunflower, it was conceived in a practical way [10]. The system has 27 prototypes of musical things, they are an audio player, a drum machine, a patch that captures audio from the microphone and guitar/bass and sends it to the network, a loudspeaker, a tuning fork, a recorder, a producer and video player. Each one of them also has several control patches, depending on their particularities. As some also support subpatches (which act as logic devices), the final number of musical things in Sunflower is 37. These prototypes were developed as Pure Data Patches[1], chosen for being multiplatform, open-access, easy to program and for being present in several systems that deal with music over the network or in real-time. Sending data to the network takes place through UDP and Open Sound Control (OSC)[2] protocol.

For the graphic properties, the authors again resorted to the multimedia capabilities of Pure Data, used to capture and reproduce video data from DVD players, webcams and laptops, in addition to performing image synthesis and processing in real-time. Image quality is more related to the equipment that records it, and like audio, it also circulates through the network through the UDP protocol. To further expand the artistic and interactive possibilities of this system, four art pieces were created using the Processing language[3]. Such art pieces are subject to changes in color pattern and movement directions, which provides to users new ways of interacting and controlling the environment.

Finally, three musical things (drum machine, microphone and tuning fork) were transposed to smartphones to be played in the MobMuPlat[4]. In this way, users gain a new platform to interact with the environment, while Sunflower accepts an easy and general-use device, allowing the integration of more people.

In the IMX 2022, a concert will be presented according to the structure shown in Figure 1. The artist connects the guitar and microphone to computer A and sends their respective sound signals (represented by the black arrows), via the network, to computer B. Data generated in the Pure Data and Processing, in addition to those captured on a webcam, are also transferred to the other machine. Computer B, in turn, receives this data (green arrows) and passes it on to loudspeakers and display screens. Audience members can participate in the art show using their smartphones and MobMuPlat app, being able to receive and manipulate musical and visual information (such as volume, reverb ratio, color pattern, videos and interactive arts features).

[1]Also known as Pd, it is a programming language and graphical environment for the development and processing of audio in real-time, developed by Miller Puckette in the 1990s, aimed at creating and composing electronic music, live performances, sound effects production, audio analysis, camera and sensor control, web interaction and multimedia art.

[2]Created in 1997 by Adrian Freed and Matt Wright to control sound synthesis algorithms. Today, OSC is used to communicate between computers, sound synthesizers, and other multimedia devices.

[3]Programming language created by Ben Fry and Casey Reas in 2001, it is originally a modification and simplification of Java language, removing the original aspects that require a deeper understanding of programming. In this way, it becomes light and easy to learn, ideal for visual works and electronic arts.

[4]Standalone application for iOS and Android, capable of hosting and executing Pure Data code. It can also perform sound synthesis, receive MIDI and OSC data via the network, display images and vector graphics, receive joystick/gamepad input and much more.

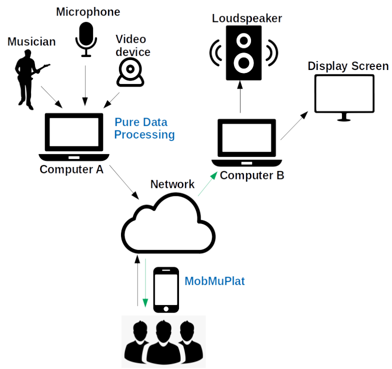

Figure 1: The Sunflower structure for live artistic performances.

4 CONCLUSION

The development of this platform proved to be a complex activity, as it requires knowledge in several areas of computer science, such as Internet of Things, signal processing, software engineering, and sound design, as well as concepts from music. The target audience for this work is made up of sound engineers, musicians, music teachers and students, scientists who are interested in research in the area, and audience members who want to participate in a more meaningful way in a show.

From an artistic point of view, the environment covers all the proposed needs, being playful and intuitive, allowing multiple users, with different goals and skill levels, to use them without major problems. Latency, which is an inherent characteristic of communication via computational means, did not interfere in a drastic way.

The presence of several multimedia devices, such as electroacoustic musical instruments, musical things, and video devices, added to the variety of data and protocols, not only guarantees the viability of the system in real and open presentations to the public but also contributes to the solution of a problem inherent to the IoMusT, which is precisely the difficulty of supporting a heterogeneous ecosystem. In this way, Sunflower appears to be a tool to be applied both in the artistic environment and in the area of computer science, especially in the exchange of musical information over the network.

REFERENCES

[1] Andre Millard. 2005. *America on Record: A History of Recorded Sound.* Cambridge University Press, Cambridge, UK.
[2] John Burgoyne, Ichiro Fujinaga, and Stephen Downie. 2016. *Music information retrieval* (1st ed.). John Wiley & Sons, Hoboken, USA.
[3] Lalya Gaye, Lars Holmquist, Frauke Behrendt, and Atau Tanaka. 2006. Mobile Music Technology: Report on an Emerging Community. In *Proceedings of International Conference on New Interfaces for Musical Expression.* Institut de Recherche et Coordination Acoustique Musique, Paris, France, 22–25.
[4] Damián Keller, Victor Lazzarini, and Marcelo Pimenta. 2014. *Ubiquitous Music.* Springer, New York, USA. https://doi.org/10.1007/978-3-319-11152-0
[5] Richard James Burgess. 2014. *History of Music Production.* Oxford University Press, Oxford, UK.
[6] Y. Rogers, H. Sharp, and J. Preece. 2011. *Interaction Design: Beyond Human-Computer Interaction* (3rd ed.). John Wiley & Sons, Hoboken, USA.
[7] Luca Turchet, Francesco Antoniazzi, Fabio Viola, Fausto Giunchiglia, and György Fazekas. 2020. The Internet of Musical Things Ontology. *Journal of Web Semantics* 60 (01 2020), 100548. https://doi.org/10.1016/j.websem.2020.100548
[8] Luca Turchet, Carlo Fischione, Georg Essl, Damián Keller, and Mathieu Barthet. 2018. Internet of Musical Things: Vision and Challenges. *IEEE Access* 6 (09 2018), 61994–62017. https://doi.org/10.1109/ACCESS.2018.2872625
[9] Rômulo Vieira, Luan Gonçalves, and Flávio Schiavoni. 2020. The things of the Internet of Musical Things: defining the difficulties to standardize the behavior of these devices. In *2020 X Brazilian Symposium on Computing Systems Engineering (SBESC).* IEEE Xplore, New York, USA, 1–7. https://doi.org/10.1109/SBESC51047.2020.9277862
[10] Rômulo Vieira and Flávio Schiavoni. 2021. Sunflower: An Environment for Standardized Communication of IoMusT. In *Audio Mostly 2021.* ACM, New York, NY, USA, 175–181. https://doi.org/10.1145/3478384.3478414