

Distributed Interactive Music Systems

A Web-based approach for Collective Multimodal Interaction

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Context and Motivation

This Phd project is integrated in one of the priority research themes at the UMR STMS on collective musical interaction, conducted in the Sound Music Movement Interaction team. This research first emerged in the ANR project CoSiMa (*Collective Situated Media*) that we coordinated [1, 2]. Following this project we pursued the development of a technological ecosystem for co-located musical interaction using web technologies [3, 4]. Recently, our ecosystem has been generalized to integrate heterogeneous sets of computers, mobile devices, micro-computer (such as the Raspberry Pi), wireless IMU sensors (Inertial Measurement Units) or wireless speakers [5].

Music and more generally artistic practices, provide us with concrete and challenging use-cases of embodied collective interaction for researching emerging novel computer-based interaction. The activity of shared and social music making is exemplary to understand and promote what we call embodied collective interaction. At IRCAM-STMS, we have been developing recently such use cases of collective music performance and concerts with auditory participation.

Our research lies therefore at the intersection of three complementary fields:

- Web technologies, with the recent specification and development of the WebAudio API [6, 7] that opened new areas in Sound and Music Computing [8] and gathered a new research community around the Web Audio Conference that we co-created at IRCAM in 2015.
- Ubiquitous and pervasive computing [9, 10] supported by the democratization of smartphones and the large spread of so-called “nanocomputers”.
- Human-Computer Interaction, particularly the *third-wave HCI* [11] considering as essential the notions of presence, expressivity, social and embodied interaction.

The development of collective, embodied and multimodal interaction, supported by the web technological infrastructure and interactive sensor technologies, remains an ambitious goal, potentially a game-changer in the current human computer interaction (HCI) paradigm.

General Goal

The general goal of this PhD is to develop novel embodied collective computer-mediated interaction paradigms and tools, with multimodal input (e.g. gesture, movements, touch, sound) and synchronized output feedback (e.g. sound/music, haptics, low-res visuals). Therefore, the goal is to significantly progress beyond the standard applications in computer-mediated communication based on text or screen interaction, by developing multimodal and synchronized interactions on heterogeneous sets of mobile, embedded and/or wearable devices.

The key points are twofold: 1) provide scalable technical solutions to enable from a few to hundreds end-users simultaneously interacting in a shared space with multimodal input and output, 2) provide high-level tools for users to design, test, and deploy such applications. The target users correspond to several communities from musicians, performing artists and educators.

Therefore the challenges consist in developing and experimenting, using web technologies, a portable, connectable and interoperable ecosystem of devices for multimodal interaction, both at input and output levels. This requires the development of overlay-network models assuring synchronisation between all these heterogeneous components. In particular, music making requires considering different timing models with controlled synchronization procedures (typically less than a few milliseconds) [12], and the ability to non-linearly navigate into these synchronized timelines. The PhD work will imply to consider implementing tools and building blocks targeted to non-developer practitioners (e.g. GUI components, high-level libraries, end-user programming strategies) for the design, prototyping and efficient testing of embodied collective computer-mediated interaction.

Concepts and technological tools will be designed and validated together with real-world applications in artistic practices, pedagogy, as well as use cases in physical training or rehabilitation in groups.

Research Domains

This PhD work can be seen as cross-disciplinary, between established research communities in Sound and Music Computing as well as HCI and UbiComp systems. In particular, communities such as WAC (WebAudio Conference that we co-created at IRCAM in 2015), NIME (New Interfaces for Music Expression) and MOCO (Movement and Computing), are interdisciplinary communities that are central for this PhD research project.

Potential Collaborations

We are currently in contact with Mozilla for developing related technologies and specifically regarding WebAudio standards, which would be beneficial for the PhD project. Collaborations with the different IRCAM departments (Music Creation Department, and Pedagogy and Cultural Actions Department) would enable concrete applications that would foster the dissemination of the research results. Other collaborations concerning the use of such technologies for rehabilitation with auditory feedback, are currently ongoing with Hôpital Pitié Salpêtrière et ISIR

Required skills

Candidates with computer sciences background, with network and distributed systems knowledge. Music knowledge would definitely be a plus.

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