

Sounding Canvas: A Networked Social Artwork Bridging Distant Communities through Tactile Interaction

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1 Program Notes

Sounding Canvas is an interactive, networked social artwork that bridges the gap between traditional fine art and digital musical expression. Inspired by the fluidity of Persian calligraphy and the structure of musical notation, the work invites participants to engage in a tactile dialogue. This Persian influence informs the visual grammar of the canvases, where gestural forms are translated into sonic mappings. By caressing the surface of the canvas, participants trigger evolving soundscapes that reflect the visual geometry of the artwork (Fig. 1).



Fig. 1. A participant interacting with Echo of Lines (prototype version) during the exhibition at Palazzo Albrizzi-Capello, Venice (Italy), April 24–May 9, 2025.

In the proposed installation, two canvases are paired via a real-time internet connection. Each touch produces sound locally while simultaneously triggering a corresponding sonic response on the paired canvas in a different location, creating a non-verbal, empathic bridge between participants.

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2 Project Description

Sounding Canvas explores the concept of "augmented paintings", traditional physical artworks embedded with an invisible "electronic brain". The project stems from a "semiographic" approach where visual shapes generate sonic material.

Participants engage directly with the canvas by touching its surface, initiating interactions that shape soundscapes in real time. Gestures are processed by an embedded software component called Event Manager, which can operate using either a Hidden-Order Markov Model or a Recurrent Neural Network to determine the canvas' sonic responses. This design emphasizes the dialogue between human and machine, allowing users to experience the canvas as a semi-autonomous, responsive partner in the creative process.

When multiple canvases are networked, this interaction extends across space: actions on one canvas influence the behavior of its counterpart, fostering a shared, collaborative experience that emphasizes non-verbal communication and social musicality. The system adapts continuously, responding to both individual gestures and remote events.

2.1 Interaction Design

The interface deliberately avoids traditional visual feedback mechanisms like LEDs or screens, ensuring focus on the physical texture and sonic response. This fosters a state of 'enactive' listening [6], where the body and the artwork are coupled in a closed-loop feedback system. While Sounding Canvas shares an interest in tactile interaction with painted surfaces with works such as Luciana Perc's *The Listening Canvas* [5], the two projects differ in their interaction paradigms. Rather than directly mapping touch gestures to sound parameters, Sounding Canvas employs an event-based decision layer based on probabilistic and learning models, allowing the system to exhibit semi-autonomous musical behavior and agency. Furthermore, the inclusion of real-time networked interaction between distant canvases foregrounds social and collective musical processes beyond individual touch-based exploration.

In contrast to standard touch interfaces that emphasize rapid, functional gestures (e.g., tapping or swiping), the Sounding Canvas encourages slow, gentle, and sustained contact. Through an AI-adaptive mechanism that incorporates interaction history, the canvas engages in a dialogic relationship with the participant, allowing the soundscape to emerge progressively.

2.2 Networked Sociality

A key feature of Sounding Canvas is its capacity to foster social interaction across distance through networked canvases, which communicate in real time with each other, allowing gestures on one installation to influence the sonic output of its counterpart. This bidirectional structure ensures both locations remain active, creating a non-verbal, empathic dialogue between participants. Users report a heightened sense of presence and co-creativity, as the system mediates responses in ways that feel semi-autonomous and socially engaging (Fig. 2).

The Event Manager allows the system to balance predictability and surprise, producing a dynamic interplay between participants even when they are physically distant. Such networked musical interaction aligns with prior research on collaborative digital music systems, emphasizing the importance of mediated interfaces in co-creative experiences [3]. Implementation details of the event manager and network synchronization layer are available in the project repository [1].

3 Technical Notes

Sounding Canvas is implemented as a hybrid hardware and software system, designed to provide a responsive, networked, and self-contained installation. Each canvas integrates embedded computation, high-precision sensing, real-time audio signal processing, and telematic communication [2].

3.1 Hardware Architecture

Each canvas contains a Raspberry Pi 4 serving as the central processing unit, responsible for running the audio engine, Event Manager, and network communication. Capacitive touch data are acquired by an Arduino Uno R3 which performs high-frequency sampling and transmits the data to the Raspberry Pi over a serial link, ensuring low-latency gesture detection (Fig. 3). This separation guarantees stable, responsive tactile interaction even under variable system load, while the Pi handles audio synthesis, adaptive modeling, and networked communication.

3.2 Sensing

The canvas surface is overlaid with hidden **capacitive sensors** made from copper or aluminum foil. These sensors detect subtle variations in electrical charge caused by user touch, even through fabric or paint layers, providing a "transparent" interface with no visible electronics. The sensor layout can capture both spatial position and approximate contact area, while the Arduino's sampling frequency ensures smooth detection of rapid gestures. Prior studies validated the reliability of this approach and its suitability for mapping to musical events [4].



Fig. 2. Two canvases engaged in networked interaction, demonstrating real-time sonic dialogue between participants.

3.3 Sound Engine

Audio signal processing on the Raspberry Pi is handled by high-performance C++ modules, while Python-based frameworks manage the overall system logic and adaptive algorithms. Gestures influence state transitions in the soundscape, producing evolving music with polyphonic output and dynamic filtering. Audio is rendered through a HiFiBerry Amp2, ensuring high-quality playback in gallery spaces.

3.4 Networking

Networked communication between canvases is managed via a **WebSocket** server, enabling bidirectional, low-latency transmission of gesture events. This design allows one canvas to influence the sonic output of another in real-time, supporting collaborative and emergent interactions across space. The system balances predictability and surprise, fostering a sense of semi-autonomous sociality while maintaining responsiveness for participants.

3.5 Installation and Deployment

The installation consists of two wall-mounted Sounding Canvases designed for flexible, site-independent deployment. The first canvas measures 70×70 cm and weighs approximately 7kg, while the second measures 100×70 cm and weighs approximately 9kg. Both must be securely mounted on a load-bearing wall using appropriate mechanical supports suitable for the wall material. Each canvas is fully self-contained, with sensors, wiring, loudspeakers, and embedded electronics enclosed behind the canvas surface and no visible external components once installed. Sufficient free space in front of each canvas is required for comfortable interaction. Each unit requires only a standard power outlet and a stable Wi-Fi connection. When connected to the internet, the canvases can communicate in real time regardless of physical distance.

4 Media Links

A mini-documentary providing a conceptual and technical overview of the *Sounding Canvas*, including demonstrations of the networked interaction between Barcelona and L'Aquila, is available at the following link:

- *Sounding Canvas | A Mini-Documentary on Augmented Paintings*: <https://www.youtube.com/watch?v=P1BjLL4bxZg>

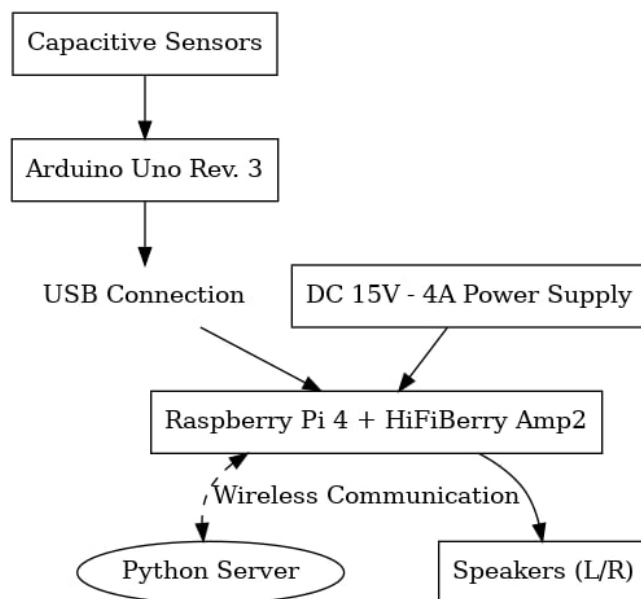


Fig. 3. System architecture of the Sounding Canvas. Touch data from the capacitive sensor array are processed by an Arduino and sent to the Raspberry Pi, which runs the Event Manager, sound engine, and network layer. The Pi is powered via the HiFiBerry Amp2, which also drives the loudspeakers. Paired canvases exchange events through a WebSocket server, enabling real-time, bidirectional interaction.

5 Ethical Standards

This project adheres to the NIME Ethical Guidelines. The authors declare no conflicts of interest. The development of the *Sounding Canvas* prioritizes sustainability by using long-lifecycle embedded components (Raspberry Pi) and traditional, non-toxic art materials. All participant interaction is anonymous; no personal data or biometric identifiers are recorded or stored by the sensors. The AI components used in the system are employed as adaptive audio processing and generative modeling tools. They do not process personal data, perform user profiling, or store interaction histories beyond the installation runtime. The project aims to promote cultural inclusivity by bridging Persian artistic traditions with Western musical and sonic practices.

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