

ECHO: Shards of sound

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Abstract. *This work is far more than just a sound sculpture or a digital musical instrument. It is, above all, an exercise in sonic memory — a living archive of Belo Horizonte’s urban soundscape. Through the act of listening and collecting, the city is mapped not by its streets or architecture, but by its acoustic textures, its rhythms, its voices, and the ephemeral sonic events that compose daily life. In an urban context where sound is often perceived as pollution — an unwanted residue of modern existence — this work proposes a different way of listening. It invites the audience to engage with the acoustic chaos of the city, not as mere noise, but as a carrier of meaning, memory, and identity. What is usually dismissed as sonic debris — engines, footsteps, metallic reverberations, overlapping conversations — becomes raw material for poetic reconstruction. Each sound fragment functions as a shard, a broken piece of the city’s auditory landscape. As participants rearrange these fragments, they build an ever-changing mosaic of stories, invisible geographies, and collective memories. What was once perceived as disorder transforms into an intimate, tactile, and deeply human experience of sound, space, and presence.*

1. Soundmaps

The initial aim was to craft a sound map of the city, inspired by Schafer’s World Soundscape Project. This endeavor sought to capture and preserve a living memory of the urban acoustic environment—an archive that transcends time, offering future generations a window into the soundscape of today. Moreover, it was meant to serve as an open resource, freely accessible online for anyone wishing to explore or analyze these sonic traces.

Working alone shaped the approach: I focused on a few select locations, with the Central Market of Belo Horizonte becoming a primary site. This choice narrowed the geographic scope but allowed for a richer density of recordings over time. Initially, this was a practical decision born of limited resources. Yet, as the work progressed, it unfolded into a deeper, aesthetic inquiry. The soundscape of a single place is never fixed; it morphs with the pulse of the week—quiet mornings give way to bustling afternoons, weekdays contrast with weekends. The seasons themselves lend their own voices, as subtle changes in weather and activity paint the space anew. And the people who inhabit the market transform it constantly, their presence a dynamic thread weaving through the sonic fabric of

each moment. Thus, the project became not only a map, but a meditation on time, change, and the living nature of place through sound.

These sound maps form the foundation of my research, serving as the primary source material for the sound sculpture created as part of the project. Beyond being an aesthetic or archival outcome, the intention was to ensure free and open access to these materials online, drawing inspiration from the open-source movement. This commitment to accessibility reflects a belief that sound, as a shared cultural and environmental resource, should remain available to all—inviting ongoing engagement, reinterpretation, and creative dialogue.

To bring this vision to life, I chose to host the sound maps website on the ALICE Laboratory’s server¹. This platform serves as a lasting digital space where the soundscapes can be freely explored, accessed, and shared—further extending the project’s reach and impact. By situating the archive within the laboratory’s infrastructure, the project gains a stable foundation, ensuring its preservation and availability for future research, artistic engagement, and public discovery.

2. Sound shards

The sound maps reveal a vast landscape of possibility within the horizon of sonic events. Much like the visual artist who gathers shards of glass or ceramic to compose intricate mosaics that transcend the mere sum of their parts, these shards of sound carry the potential to shape entirely new auditory worlds. Each shard is a distinct piece of the city’s acoustic fabric—raw, textured, and laden with memory—waiting to be reassembled and reimagined into novel soundscapes [1].

In sound art and acoustic ecology, this process resonates with the practice of sonic collage, where discrete sonic elements are juxtaposed and layered to evoke fresh meanings and affective textures [2]. The shards of sound act as both material and metaphor: they are residues of lived experience and place, yet through creative recombination they become dynamic building blocks for new sonic narratives. As Deleuze and Guattari (1987) describe in their theory of assemblages, such reassemblies allow the deterritorialization and reterritorialization of sound, opening space for renewed modes of listening and understanding [3].

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¹ Available at xxxxxxxxxxxxxxxxxxxx

This approach aligns closely with Schafer's concept of the soundscape as a palimpsest—an ever-shifting layering of sounds where past and present coexist in tension and harmony [1]. Like shards in a mosaic, these sonic pieces—when thoughtfully arranged—offer portals into unexpected acoustic geographies, inviting us to experience the city not as a fixed backdrop but as a living, breathing composition. Through this process, the ordinary is transformed, and the act of listening becomes an exploration of time, space, and memory woven together by sound.

3. The body

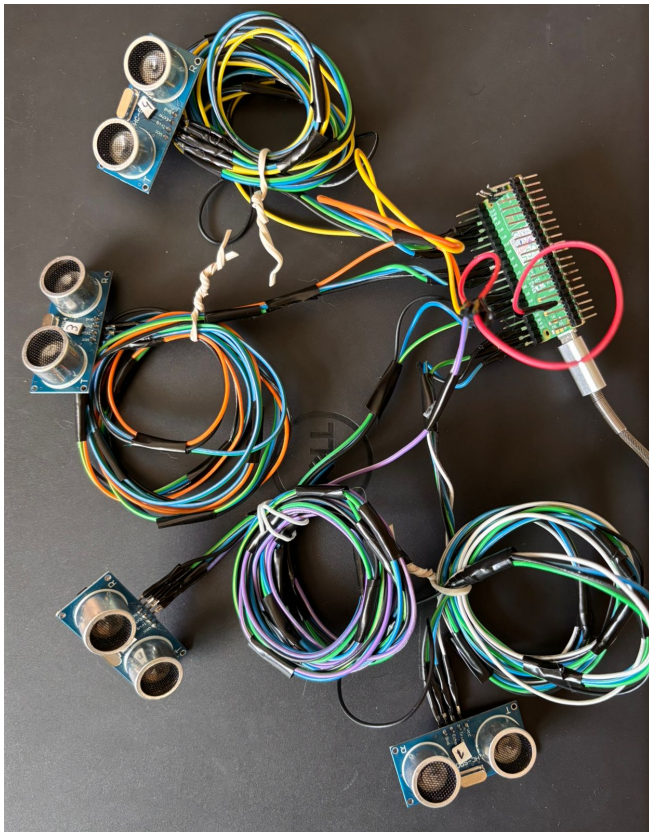


Figure 1: Internal system of the sound sculpture, composed of proximity sensors, a Raspberry Pi Pico, and wiring.

Just as any musical instrument possesses a physical body—a tangible vessel that resonates—the digital musical instrument and sound sculpture I envisioned also demanded a corporeal form. To pull it out from the abstract realm of ideas and bring it into existence, I turned to the field of musical computing. The system was built using a Raspberry Pi Pico microcontroller in combination with HC-SR04 ultrasonic distance sensors, forming the technological backbone for performer-instrument interaction.

In an ideal scenario, I wished for this instrument to operate entirely autonomously, without the need for a computer. However, the financial constraints of acquiring the necessary hardware for a fully standalone system exceeded my available resources. This led me toward the



Figure 2: External structure of the sculpture, made of metal and fabric.

use of microcontrollers—a compromise that, while dependent on a computer for processing, remained economically feasible. Similarly, the choice of sensors was guided not only by technical requirements but also by the boundaries of material reality and accessibility.

A key design principle was approachability. I aspired to create an instrument that anyone could play—regardless of prior musical training. This is why I chose proximity sensors: they allow sound to be triggered through simple, intuitive gestures. As the distance between the performer and the sculpture changes, the sensors activate and modulate sound samples, transforming movement into music. In this way, the instrument becomes a tactile, spatial, and sonic experience—an invitation to explore sound through the body's presence in space.

The external body of this instrument—this sound sculpture—was conceived as a kind of skin, a fabric that gently envelops its inner anatomy. Like flesh covering arteries and organs, the textile layer conceals the wiring and the sensors, wrapping the technological core in a soft, organic presence. What remains visible is not the circuitry nor the mechanics, but rather what emerges from it: the sound itself.

This design choice was intentional. It seeks to balance visibility and mystery—to invite curiosity about the physical object without allowing its visual presence to overshadow the sonic experience. The skin acts as a threshold between the visible and the audible. It softens the relationship between the audience and the machine, encouraging listeners to focus primarily on the acoustic space that the sculpture generates, rather than on the technological apparatus that enables it.

In this way, the body of the instrument becomes not a spectacle, but a vessel—a quiet container for sound to emerge, vibrate, and inhabit space. The visual is present, yes, but it exists in service of the auditory. The sound remains the central protagonist.

4. The soul

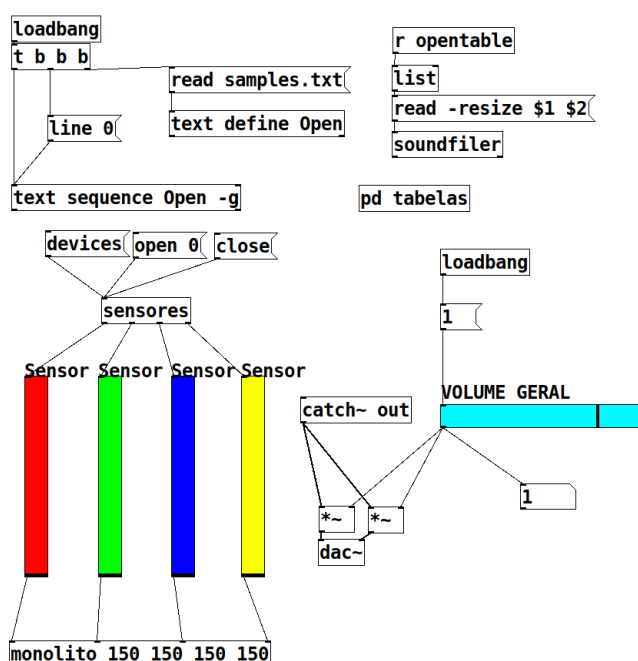


Figure 3: Pure Data main patch.

If the physical body of this instrument finds form in its structure, then its soul resides in the invisible logic that animates it. Much like a violin depends on its alma—that slender wooden dowel hidden inside the instrument, crucial for transmitting vibration and resonance—this sound sculpture relies on code as its vital force, its immaterial essence.

Without this coded soul, the sculpture remains silent, inert—an empty vessel. It is the code that breathes life into the system, translating the gestures of the performer into sound, transforming proximity into resonance, and presence into music. This intangible framework was crafted using Pure Data, a visual programming language widely embraced within the fields of sound art and experimental music for its open-source ethos and modular, generative capabilities.

The choice of Pure Data was not merely techni-

cal, but also philosophical. Its open, flexible nature mirrors the conceptual foundation of the piece itself—an artifact that values accessibility, transparency, and the possibility of perpetual transformation. Just as the violin’s soul connects its body to its voice, the code connects the sensors, the performer, and the audience to the ephemeral, living presence of sound.

Figure 3 presents the main patch of the instrument². Reflecting the physical design of the sculpture—which is structured with four sides, each equipped with a proximity sensor—the patch mirrors this architecture with four corresponding sensor modules. Each sensor is mapped to trigger four distinct sound samples, all sourced directly from the sound maps recorded throughout the city. In total, the system contains sixteen samples; however, this number is entirely flexible and can be adjusted according to the needs of each performance, space, or creative intention. The structure is not a limitation, but rather a suggestion—a framework open to transformation.

In line with the conceptual foundations of this work, the complete patch will be made freely available through an open-access link, inviting others to explore, study, and even reconstruct the instrument in their own contexts. However, this availability comes with clear boundaries: this work is shared for educational, artistic, and personal use only. I explicitly reject and prohibit any use of this patch or its components by corporations or entities seeking commercial gain from my artistic labor. This is a work rooted in the ethics of sharing, collaboration, and artistic autonomy—not in the logic of exploitation. Any attempt to appropriate this artwork within a corporate framework stands in direct opposition to the spirit in which it was created.

5. Performance, sound and presence

Sound is inherently performative. Unlike visual or physical objects, sound only exists when it happens — in time, in space, and in relation to bodies. It is not something fixed or static but an event that emerges, unfolds, and disappears. Listening, therefore, is never passive. It’s an active engagement, a form of participation in the acoustic unfolding of the world.

Drawing from Richard Schechner’s *Performance Studies*, performance is not merely about representation but about transformation and presence. A performance happens when bodies, actions, and contexts meet in a shared space of experience. In this sense, sound operates exactly like a performance: it’s ephemeral, relational, and deeply tied to the presence of both the emitter and the listener.

J.L. Austin’s theory of performative utterances further deepens this understanding [4]. For Austin, language doesn’t just describe reality — it can create it. When someone says, “I now pronounce you married,” the act of saying is itself the act of doing. Similarly, when a sound

²Available at xxxxxxxxxxxxxxxxxxxx

occurs — whether it's a voice, a machine, or a curated sound in an artwork — it doesn't simply reflect the world; it actively constitutes reality in that moment.

This project embraces sound not as a representation of the city but as an action within it. Field recordings become more than archives — they are fragments of living environments that, when reassembled, generate new sonic experiences and meanings. Each listener becomes a performer, activating the work with their presence, their gestures, and their attention.

Schechner reminds us that presence in performance extends beyond the physical. It holds layers of memory, history, and collective experience. A simple market sound can evoke personal memories, cultural identities, or even collective emotions tied to that place. Sound carries the invisible geographies of a city — its rhythms, tensions, and social dynamics.

From Austin's perspective, every act of listening within this installation is a performative act: the sounds don't just represent the city — they do something. They invoke, they transform, they create new spaces of meaning.

In this way, the sculpture is never complete by itself. It only fully exists when it is activated — when someone steps close, listens, moves, and interacts. Presence becomes not only physical but also political and poetic: an invitation to shift from passive hearing to intentional listening, where sound becomes an act of care, attention, and co-creation.

6. Sound Politics

Listening is, above all, an active practice. It's not just about capturing sounds, but involves attention, presence, and relationship. In the city, where sounds overflow beyond control, listening becomes a way to perceive what is usually ignored: the invisible layers of life, memory, and conflict that the sound environment carries. It is at this intersection of aesthetics, ethics, and politics that this work takes its place.

When we think of listening as an aesthetic practice, it's clear that it is never neutral. To listen is to choose, to filter, to create meaning. And often it's also to let oneself be crossed by chance, noise, and what escapes. From this perspective, sound does not behave like an image: it doesn't define clear edges or stay fixed on surfaces. Sound overflows, mixes, and passes through. This condition causes both discomfort and power because it calls for a listening that is at once open and involved.

The very sound composition that emerges from the sculpture presented here relies on this principle. It doesn't seek a clean, idealized, or purified sound. On the contrary, it celebrates noise, error, and unpredictability. Fragments of conversations, engines, footsteps, horns — everything that makes up the city's background (or perhaps its foreground) — becomes aesthetic material. Chance is not noise in a negative sense; it is poetic fuel. So, composing with city sounds means accepting the unpredictable as

a fundamental element, giving up total control in favor of a listening made in encounter, in the present, in relation.

But listening is also crossed by issues beyond the sensory. Sound in the city carries social, political, and economic marks. Not everyone makes noise in the same way — and even more, not everyone has the right to be heard. There are sounds that are authorized and sounds that are systematically silenced. Thinking in terms of *soundscapes* is also thinking about struggles for space, territory, and existence. The concept of sonic gentrification emerges exactly from this clash. As certain sounds — from markets, fairs, popular cultural practices — are gradually removed in favor of a sanitized soundscape, it becomes clear that there is a violence that is not only visual or economic, but also acoustic. Those who live in the city know: some neighborhoods can protect themselves from noise, with insulation and bought silence. And there are others where the sound of precariousness imposes itself, either through excess or prohibition.

In this web, listening also becomes an ethical question. And this is exactly the path that Bastos follows when she talks about sonic ethics: understanding that listening is, first of all, recognizing the other [5]. Sound is not just something to perceive; it is something to share. Therefore, listening cannot be a closed practice but an openness, a willingness. It's a constant question: who am I willing to listen to? Who is obliged to listen to me? Who has been silenced in this space?

This ethics is deeply connected to the idea of deep listening, as proposed by Oliveiros [6]. More than a technique, it is an affective and political disposition to hear what is present, what was forgotten, what resists. A listening that doesn't only seek beautiful or pleasant sounds, but also embraces discomfort, friction, and difference. Similarly, when LaBelle talks about acoustic territories, he invites us to see that each sound space is also a social space, continuously constructed and negotiated. Sound does not just occupy space: it creates space[7]. And creates, along with it, relations of power, belonging, and exclusion. It's no coincidence that many urban complaints are about sound: either the sound "of the other" or the absence of a sound that should be there. Salomé Voegelin, in turn, reinforces this idea by proposing that listening is not a search for objective truths but a way of constructing worlds [8]. When we listen, we are actively participating in the production of meaning and reality. Sound is not just a reflection of the city — it is the city in happening.

In this work, these principles are not just theoretical concepts but embodied practices. Choosing sounds from everyday urban life, making them available as material open to public interaction, and allowing chance, presence, and movement to shape the composition is a choice that carries both a poetics and a political stance. The sculpture does not offer easy answers; it offers listening. And in this gesture perhaps lies its transformative power: to make audible what is often invisible.

7. Conclusion

This work operates at the intersection of sound art, acoustic ecology, and digital lutherie, but it also emerges as a critical space for negotiating the complex entanglements between humans, machines, and the environment. Rather than functioning as a static object, the sound sculpture configures a dynamic interface that invites an active and participatory form of listening. Fragmenting, archiving, and re-composing the sonic fabric of the city, it repositions noise as memory and residue as material, offering a reorientation in how urban soundscapes are understood and experienced.

The sculpture exists not simply as a physical apparatus, but as a living entity—its metals, circuits, fabric and code functioning as limbs of a larger sentient system. Its sensors respond to human presence, inviting interaction. Its electronic heart pulses with rhythms shaped by chance and intention. This integration of machine and human agency underscores the notion that listening is not passive reception but co-creation. The sculpture invites its users to become performers, to treat sound not as data to be consumed, but as matter to be shaped, felt, and inhabited.

Within this active listening space, the notion of care takes center stage. Pauline Oliveros' concept of "deep listening" becomes essential here—not just as a technique of expanded auditory awareness, but as a mode of ethical engagement with the world. Listening becomes a practice of care for the sonic textures that surround us, many of which have been historically overlooked, silenced, or dismissed as noise. This care extends to the environment, to memory, and to the ways sound shapes our social and emotional relationships to space.

Built using Pure Data, the sculpture embraces the ethos of open-source culture, encouraging replication, modification, and shared authorship. This transparency aligns the work with a broader movement of technological democratization and critical making, in which computing is reimagined as an expressive and political act.

In this sense, the work resonates with Salomé Voegelin's argument that listening is a generative and relational act, one that constructs rather than merely reflects the world. The sculpture enacts this generativity by re-assembling the fragments of urban sonic life into new constellations. These constellations are not stable compositions but open-ended invitations—scores without fixed outcomes.

Chance plays a central role. Instead of being suppressed in favor of controlled output, unpredictability is embraced as a poetic force. The sculpture functions as a mobile site of territorial negotiation. It captures and amplifies those sounds that mark zones of social tension: street vendors, alarms, informal labor, birdsong trapped in cages. These sounds, often considered pollutants in the dominant urban order, become central actors in the performance.

The notion of the "right to make noise" becomes a political question. In many contemporary cities, sound is tightly regulated, and the ability to produce or suppress

noise correlates with social privilege. The sculpture intervenes in this politics by valorizing what is usually ignored: spontaneous sonic events from the periphery, the background textures of daily life. It amplifies them not only physically but symbolically, insisting on their value and presence.

This intervention also operates at the level of urban spatial politics. The sculpture materializes a critique of sonic gentrification—the process by which certain soundscapes are deemed more desirable than others, leading to the marginalization of specific auditory cultures. Just as neighborhoods are transformed and displaced through real estate speculation, their soundscapes are sanitized, policed, and curated. The sculpture resists this by preserving and remixing the raw, and the noisy.

Materiality is essential here. In resisting the trend of total digital abstraction, the sculpture maintains a strong physical presence. It demands proximity. In doing so, it challenges the distancing effect of much contemporary digital art, which often privileges screen-based interaction. Here, the digital and physical are fused. Code becomes muscle. Circuitry breathes. The machine is not an invisible hand but a partner in a haptic and sonic dialogue. The system remains open to interruption, allowing the unexpected to enter. This openness is an aesthetic and political stance: a refusal of determinism, a welcoming of the other.

Computation here is poetic. It is not neutral. It carries with it assumptions, values, and possibilities. The sculpture's hybrid architecture—merging recorded audio and physical interaction—demonstrates that digital instruments can foster embodied, situated, and affective experiences. It suggests that technological systems can be built not just to control but to relate, to evoke, and to care.

In this way, the sculpture encourages what Oliveros called a "listening attitude." It places the listener in a position of responsibility. Sound is not merely encountered; it is participated in. This listening is ethical, political, and ecological. It attends to the silences, to the background hums, to the uneven distribution of sound in the urban landscape. It insists that to listen well is to live well. The ecological dimension of this work goes beyond environmentalism. It addresses the full ecology of sound—its social, cultural, psychological, and spatial dimensions. In a world overwhelmed by sonic clutter, much of it generated by engines, advertisements, and alerts, this sculpture provides a space of sonic refuge. But it does not romanticize quietude. Silence, too, can be violent. What it offers is attentiveness—a chance to hear differently.

Through its sonic interventions, the sculpture encourages reinhabiting the city. It invites the listener to walk differently, to hear layers once filtered out. It proposes a new cartography of place—not based on visual landmarks but on acoustic cues. It gestures toward a sound-based belonging, one not defined by property lines but by resonance. From the perspective of digital lutherie, this sculpture challenges traditional notions of instrumentality. It is not a tool to be mastered, but a partner in improvisation.

It invites failure, repetition, variation. This demands a different kind of virtuosity: one based on listening, patience, and responsiveness.

By resisting the logic of optimization, the sculpture aligns itself with practices of slowness. It asks the participant to linger, to return, to explore. In doing so, it also resists commodification. It cannot be reduced to a product or consumed in a single interaction. It is incomplete without the listener, and even then, never finished.

The project repositions sound not as an object but as a relation. The soundscape is not a backdrop but a co-creator. In this framing, every listener is also a contributor, and every space is always in flux.

In sum, the sculpture proposes a new ethics of sonic interaction. It affirms the value of noise, the dignity of the minor, and the potential of technology as a site of care. It transforms digital media into instruments of connection. In doing so, it offers a powerful response to the alienations of contemporary urban life—not by withdrawing, but by listening deeper.

The future this sculpture imagines is one where sound is not a nuisance to be managed, but a commons to be shared. Above all, it asks us to re-learn how to listen—together.

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