Resonance: a collaborative multiuser interface to create an inclusive audiovisual sound art performance

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Abstract

In this short paper we discuss how neurodiverse individuals participated in a creative, artistic activity through group interaction mediated by a multiuser interactive audio-visual interface called Resonance. The Resonance digital interface enables sound art making and group performances in communities with disabilities. We combine principles from interaction design and tangible user interaction in a community arts context to examine how shareable interfaces for sound art performance can promote inclusion and wellbeing in the arts. We reflect on our approach and workshop development that support individual and group creativity. We discuss the potential of the Resonance technology to empower individuals with disabilities to co-create sonic art forms that foster a sense of independence and inclusion.

Keywords

Interactive Art, Sonic Arts, Participation, Interaction Design, Inclusive Arts

Introduction

Interactive technology presents a transformative opportunity to design and customize environments and interfaces, that facilitate engagement for individuals, both with and without disabilities. However, participation in the arts for neurodiverse individuals has historically been confined to traditional genres like dance, visual arts, crafts, music, and theatre. [1]

Within the Australian context, recent statistics reveal that up to two-thirds of people with disabilities have yet to partake in a community arts experience in collaboration with practicing artists. This statistic is notable, especially considering that 60% of surveyed Australians acknowledge the positive impact of the arts on their well-being and happiness. Engaging in community arts-based activities offers potential therapeutic outcomes. For instance, within Community Music contexts, there is a notable emphasis on the values individuals can derive from participating in collective music-making. [2] While therapeutic gains may not be the explicit goal of such activities, they are often observed, encompassing benefits related to social inclusion, physical health, and mental well-being.

Recognizing the potential benefits of group participation in community arts contexts, we explore how technology may assist artists create and perform sonic experiences with a particular focus on designing inclusive digital interfaces. Since 2014 we have collaborated with community arts organisation JOLT Arts and The Amplified Elephants – a sonic art ensemble of neurodiverse artists, mentored and produced by JOLT Arts. The Amplified Elephants have generated a variety of projects employing innovative methods to elicit soundscapes and craft performance art. These projects often involve the use of novel technologies, modified traditional instruments, and discovered objects to make sound. Here, we report on the development of a performance called Select Naturalis using a multitouch tabletop interface called Resonance designed by the author.

Resonance

Resonance is a custom designed multiuser audio-visual tool that facilitates improvised music making and sound art performances within community arts and disability contexts. Our work draws from exemplars of inclusive technology design in the arts that have demonstrated the capacity to amplify opportunities and developmental requirements for individuals with disabilities. Such designs serve to extend invitations for greater participation in cultural activities. [3-4]

Resonance is designed to facilitate collaborative and cooperative interactions among small groups of performers (1-4), positioned around a 55” tabletop display. Group participation and group ‘negotiation’ is fundamental to the experience of Resonance and builds upon prior work, which supports upper-limb rehabilitation for individuals with traumatic brain injury. [5]

The tool allows for the generation of intricate soundscapes, achievable both individually and collectively, through the utilization of basic gestures, movement, and manipulation of tangible objects (referred to as tangible user interfaces, TUIs) on the display. Within this setup, participant groups engage in the mixing and manipulation of sound and vibrant graphics to create aesthetically pleasing compositions.

The Resonance interface encourages improvisation by imposing only the most straightforward "user" rules and structures on the participant. The overarching design of the interface centers around embracing inclusivity and nurturing

participation—where anyone can actively create and perform, ensuring that everyone possesses something valuable to contribute when given opportunities for involvement. The intuitive interface eliminates the necessity for formal musical training and permits potentially playful approaches that operate outside traditional constraints like harmonic structure, rhythmic patterns, or tonality in music allowing interaction to occur without such considerations. Improvisation serves as a catalyst for individuals to playfully experiment with sounds, introduce novel ideas, perhaps mirror the auditory landscape around them, embrace or challenge the musical flow, and cultivate or abandon a stream of musical thought.

The Resonance Design

Our design methodology is influenced by the principles of Computer Supported Cooperative Work (CSCW), a subset of Human-Computer Interaction (HCI) that explores how computers can mediate and enhance collaborative efforts within group settings (for a more comprehensive discussion, see Duckworth et al). [5] Researchers and designers in HCI have long been exploring horizontal computing form factors. For instance, Weiser and Wellner delved into multimodal tabletop interaction in the early 1990s through the creation of the Digital Desk. [6] Other innovations in tabletop displays, such as reacTable™, have allowed for reliable sensing of rich multi-user touch input and tangible object user input. [7]

The advantages attributed to horizontal interactive surfaces include user-friendly and intuitive direct finger touch interactions, a brief learning curve for novice users, support for collaborative activities, and the tracking of tangible user interfaces. The use of tabletop displays is particularly lauded for its ability to enhance awareness of others' actions, a significant advantage in collaborative face-to-face activities. [5]

Tangible User Interfaces

Up to four TUIs positioned on the tabletop display serve as the primary means for users to naturally control features and events within Resonance. Each TUI generates a distinct set of sounds, encompassing notes, pulses, and atmospheres. When placed on the display, each TUI produces a series of colored lines radiating from its base along a central axis. These lines visually segment the screen into colored polygonal fragments, triggering an audiovisual note when touched (see figure 1).

As TUIs are added to the display, additional fragments are generated, expanding the range of playable notes. Different sound intensities are produced through single-touch and multi-touch gestures, creating softer and louder sounds, respectively. The size of the fragments changes as the TUIs are slid across the display, influencing the pitch of the notes based on their position.

An additional feature involves a circular array of graphic buttons around the base of each TUI. When activated by touch, these buttons generate glowing pulses at regular intervals. These visual pulses travel along lines extending from the TUI, producing a percussive sound when they intersect with other lines. The pitch of the sound varies by adjusting the intersection points, with closer or farther intersections from the base altering the pulse pitch.

Figure 1. The Resonance multiuser tabletop display and Tangible User Interfaces ©Photo courtesy of Jonathan Duckworth.

Furthermore, rapid rotation of the TUI controls the playback speed of an atmospheric sound, with clockwise and anti-clockwise movements determining forward or backward playback. A circular ring around the TUI's base signifies this feature, and volume adjustment for the atmosphere can be achieved through a pinch-like finger gesture over the ring. For instance, pinching the ring inward decreases the volume. By employing a combination of these straightforward gestures and movements, participants can collaboratively craft intricate soundscapes.

Technical Implementation

Resonance uses a 3M Multitouch PCAP (Projected Capacitive) display that supports 80 simultaneous touch points. This allows for four TUIs with overhead for multiple hands for concurrent touch interaction.

The interactive visuals, tangible tracking and audio subsystems have all been developed using the Unity™ game engine and C#. Each TUI has a unique constellation of three raised conductive touch points on the object base. These constellations are defined by the side length and winding of the resulting triangle formed from the three touch points, along with a position and rotation offset to describe the centre of the TUI.

The audio system implements “Instrument” playback on top of Unity’s sample-based audio system. Each Instrument consists of an ADSR volume envelope (Attack, Decay, Sustain, Release), an attack audio sample and a looping sustain audio sample. These Instruments are pitched to a chromatic scale that covers 4 octaves, using the X+Y screen coordinates with the lowest pitch in the bottom left corner. Resonance contains three separate audio “Banks” that can be switched live. Each Bank contains 8 Instruments and 4

looping samples: One Fragment Instrument, one Pulse Instrument and one Atmospheric looping sample for each of the four Tangibles.

Developing Select Naturalis

Over a span of three months, The Amplified Elephants underwent mentoring by Hullick in weekly five-hour workshops to develop and refine their performance of Select Naturalis (see Figure 2). Inspired by Charles Darwin's concept of evolution and natural selection from the perspective of intellectual disability, The Amplified Elephants explore an evolving world of sounds that suggest the micro – such as cellular organisms – to the macro – large-scale, though imaginary life forms.

Figure 2. Select Naturalis performance, Bendigo International Festival of Exploratory Music, featuring The Amplified Elephants. © Photo by Owen McKern courtesy of JOLT Arts

Resonance served as a central element, guiding both structured improvisational processes (such as following a predetermined order for activating sounds) and free improvisational activities (spontaneous improvisation without prior conditioning). The artists recorded these improvisations and subsequently engaged in a process of listening and 'sonic adventuring,' a term coined by Hullick. This approach involved exploring and experimenting with sounds, serving as the foundation for creating sound art—an umbrella term encompassing any creative activity that prioritizes sonic elements.

Workshop Approach

Hullick collaborated with the entire group as well as each individual artist to discern their capabilities in producing sound and to understand their preferences and inclinations toward different sonic elements. The Amplified Elephants delved into various sonic techniques, encompassing the recording of synthesizer-based drones, spontaneous improvisation with percussion and found sound objects, and the utilization of traditional musical instruments.

Additionally, the group explored abstract vocal expressions, recording, and editing source audio samples with an 'animalistic' quality. These recorded sounds were subsequently edited and incorporated into the Resonance software, specifically within the notes, pulses, and atmospheres sound databases.

Hullick attentively observed the diverse capabilities exhibited by individuals within the group, such as their proficiency in manipulating the graspable objects on the display and how they employed Resonance's functionality to engage in collaborative improvisation with fellow performers. Group members conducted their improvisations in the presence of one another, fostering a setting where the ensemble collectively deliberated on the performances and contemplated potential enhancements. Every ensemble member was afforded the opportunity to experiment with various sound-making activities on the Resonance table.

Usability Observations

Following the workshops, Hullick provided several insights into the usability of Resonance and the perceived positive impacts on The Amplified Elephants. The strategic placement of the system in the workshop rehearsal space proved invaluable, offering a comprehensive understanding of how performers engaged with Resonance and providing valuable insights for system enhancement. The mode of interaction facilitated a variety of intricate social and physical exchanges among groups of performers. Observing others' successful improvisations related to the theme of evolution appeared to instill a sense of self-efficacy in the performers, fostering confidence in their ability to create and share meaningful sonic art.

Significantly, performers demonstrated an intuitive and playful use of the system, engaging in movements requiring fine motor control, touch-related actions, spatial arm orientation, and modulation of force when manipulating the TUIs. These functional motor skills, often challenging for participants with intellectual disabilities in other contexts, were successfully performed. Hullick noted that the enjoyable nature of the instrument motivated artists to push themselves further in refining fine motor movements and control.

Engaging with Resonance offered the opportunity for artists to "learn from others," fostering the development of social skills and confidence. It also served as a source of motivation for individuals to actively participate and collaborate with fellow performers. The observed outcomes from Resonance-based workshops and performances suggested that technologies integrating co-located social play serve as a potent tool for individuals with intellectual disabilities. Hullick observed that such technologies enhance social engagement and inspire active participation in sophisticated creative experiences, thereby positively reinforcing their rightful and dignified place within evolved communities.

Engaging playfully with Resonance inspired artists to explore different positions around the table, allowing them to stand, sit, and discover new access points to investigate the sound-making capabilities of each TUI. When an artist identified a sound deemed potentially useful for composition, they directed the group's attention toward it. A curated selection of preferred sounds served as the

foundation for various improvisations performed by ensemble members both for and with each other.

Hullick discerned that the group engaged in numerous artistic feedback loops, empowering the artists to shape sonic realms reflective of the ensemble's identity. The resulting performances on Resonance by The Amplified Elephants featured interspersed readings of quotations from Darwin's research. This prompted significant inquiries for both audiences and artists, including the role of individuals with intellectual disabilities in the theory of evolution.

The Resonance interface, functioning as a sonic instrument supporting group thinking and problem-solving strategies, emerged as the ultimate resolution. It underscored that individuals of all abilities could collaboratively deliver a beautiful, poetic, and aesthetically enriching experience to the community.

Discussion and Conclusion

Upon reflecting on the participants' observed interactions during the development of Select Naturalis, we have gained some initial insights into the usability of co-located sharable interfaces such as Resonance that empower artists with disability in crafting performances. The interactions observed highlighted how the physical space and spatial orientation of the user around the Resonance display influenced their comprehension, coordination, and communication with others in a collaborative setting.

The physical and digital artifacts helped maintain the groups focus and facilitated group awareness. Awareness of what others in the group are thinking and doing was essential in coordinating collaborative sound making and achieving common goals around developing the performance. Such collaborative activities were effective when Resonance was a shared resource among the group, using gestures and moving the TUIs to communicate their ideas and understanding of others.

With groups of users comes the possibility for individuals to interact simultaneously with others around Resonance interface. Concurrent interaction among the group enabled a wide variety of collaborative styles, including working in parallel, working sequentially, working independently, and working in assumed roles. We observed that shareable interfaces promoted more group participation, highly coordinated forms of collaboration, and verbal communication when multiple entry points for interaction were supported. Importantly, the tangibility of the interface seemed to encourage greater participation from individuals who normally find it challenging to communicate verbally or those who find contributing to a group setting socially challenging.

We view our work as an ongoing effort contributing to a more extensive research inquiry aimed at comprehending interaction design within the realms of participation and community art that warrants further investigation. Our objective is to nurture inclusion and contribute to positive transformations in individual and collective well-being. Our primary focus is on enhancing the quality of life and participation for both individuals and communities through interactive art technologies, with a particular emphasis on neurodiverse individuals. In this context, Resonance is perceived by the authors as an inclusive musical instrument with considerable potential to enhance the well-being and creative capacity of its users.

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Authors Biographies

Jonathan Duckworth is an Associate Professor and co-director of CiART (Creative interventions, Art and Rehabilitative Technology), at the School of Design, RMIT. His practice-based research relates to design innovation within allied-health, the arts and human computer interaction technology.

James Hullick is a pioneering Australian sound artist, composer, performer, and artistic director. He is the CEO of JOLT Arts, the JOLTED Arts Space, and the BOLT ensemble. He is a mentor to The Amplified Elephants and many artists with and without disability.

Ross Eldridge is a creative coder and senior programmer at CiART, School of Design, RMIT. He explores the technical side of creating real-time interactive visual and audio experiences. His primary skills relate to developing interactive virtual environments, input tracking systems and real-time 3D graphics.