Learning to Move, Learning to Play, Learning to Animate: a Multimedia Exploration of the More-than-human Intelligence

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This paper presents *Learning to Move, Learning to Play, Learning to Animate*, a cross-disciplinary performance presenting a narrative where humans, robots, synthetic embodiments, and organic entities interact across multiple layers of reality, reflecting our increasingly hybridized world. Rooted in the conceptual foundation of more-than-human intelligence, we connect our conceptual exploration with the stage design, choreography, and technical system design, blending natural and synthetic elements. The performance critiques anthropocentrism and highlights themes of interconnectedness and shared environments, inviting audiences to reconsider the agency of non-human intelligence and explore the potential of co-creativity across natural and synthetic boundaries.

CCS Concepts: • **Applied computing → Performing arts**; **Media arts**; • **General and reference → Design**; • **Computing methodologies → Artificial intelligence**.

Additional Key Words and Phrases: Interactive Multimedia Performance, Real-time Generative AI Art, More-than-human-world, Found Object Robotics, Bio-feedback Sonification and Visualization

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1 Introduction

What does it mean to be intelligent? Is intelligence uniquely human, or can it take forms we often overlook—embodied in wood, stone, metal, or silicon? As artificial intelligence advances rapidly, its definition remains elusive, frequently framed as an alien force that threatens to overshadow human agency. Yet, intelligence surrounds us in ways we are only beginning to recognize, embodied by the intricate systems of animals, plants, and ecosystems that reveal profound complexity and agency.

Ecologist and philosopher David Abram describes "the more-than-human world" as a perspective that dissolves the divide between humanity and the natural environment [Abram 2012]. This way of thinking invites us to consider intelligence not as a hierarchy but as a network of interdependent systems—human, technological, and ecological. Our work reflects this shift, exploring what it means to exist in a world where nature and technology are not opposites but co-creators of a

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shared intelligence. How can we coexist without domination, recognizing the agency of all forms of intelligence?

In our performance, *Learning to Move, Learning to Play, Learning to Animate*, we examine these questions through organic material robotics, AI-generated visuals, real-time biofeedback interactive soundscapes, and a narrative of human and machine learning through movement. This multimedia exploration invites audiences to reflect on *learning*, *interaction*, and *perception* within the more-than-human world, bridging the natural and synthetic in search of shared meaning, which is increasingly vital in a time when ecological crisis and technological acceleration urge us to rethink how we define intelligence and relate to other forms of life and matter.

Fig. 1. A still from our performance, where we merge the organic and the synthetic, where the performer, the plants, and the shadow are united in movement.

2 Motivation: A narrative in a more-than-human world

The concept of the more-than-human world highlights the interconnectedness of human, non-human, and technological entities. David Abram's *The Spell of the Sensuous* [Abram 2012] advocates renewed sensory engagement with nature, challenging anthropocentric perspectives. Similarly, James Bridle's *Ways of Being* [Bridle 2022] urges an inclusive and empathetic understanding of technological and ecological intelligences. Our work draws on these philosophies and speculative ecological visions, such as Pinar Yoldas's *Ecosystem of Excess* (2014), imagining organisms evolved to metabolize plastic waste [Yoldas 2014], Anicka Yi's *In Love With The World* (2021), envisioning hybrid biological-technological entities [Yi 2021], and Memo Akten's generative AI-driven *Deep Meditations: A brief history of almost everything* (2018), revealing ecological interconnectedness [Akten 2018].

Our robots embody the vitality of plant life, inspired by Charles Darwin's documentation of plant movements in *The Power of Movement in Plants* (1880), describing growth patterns as gentle spiraling movements—nature's own "hello world" (Fig. 4a) [Darwin et al. 1883]. Further inspiration comes from forest communication networks, known as the "internet of trees," where roots and fungi form interwoven systems of exchange [Bridle 2022]. These natural processes exhibit intelligence paralleling our technological innovations, suggesting that coexistence and co-evolution with nature and technology is an ancient wisdom our performance aims to convey. These insights inform our integration of found-object robots and plant bio-feedback, influenced by artworks like Christa Sommerer and Laurent Mignonneau's *Interactive Plant Growing* (1992), in which human interaction shapes virtual plant growth [Sommerer and Mignonneau 1992], and Špela Petrič's *PL'AI* (2020), where an AI-powered robot engages interactively with cucumber plants, exploring curiosity and sentience beyond humans [Špela Petrič 2020].

We chose performance art for its ability to embody and communicate complex relationships among humans, machines, and nature through immediacy, presence, and live interaction. This form allows us to shift audience perspectives beyond anthropocentrism by directly engaging them with interspecies and synthetic connections. While drawing from the foundational legacy of post 1960s performance art, including Stelarc's *Third Hand* [Stelarc 1980] and Paik and Moorman's *TV Cello* [Paik and Moorman 1971], which explored the human body and machine, our work moves toward ecological entanglements and more-than-human agencies.

3 Stage Design and Narrative Overview: Representing Interconnected Realities

Our stage design is rooted in a conceptual exploration of interconnectedness, interdependency, and coexistence, embodying the more-than-human world. We illustrate the physical setup in Figure 2, and the system design in Figure 3. The space is conceived as a coexistence of shared realities, which include the collective environments that are co-created by beings on earth, alongside synthetic realities that manifest as computationally generated environments, or imagined worlds. The main projection screen at the center serves as a fluid boundary between these dual realities. The foreground, representing our shared reality, contrasts with the synthetic reality depicted on the main projection screen.

Our narrative (illustrated in Figure 3b) tells the story of embodied beings (performers, robots, plants) at the intersection of these dual realities, exploring and interacting with the space and each other. Shadows are an important element in this performance. As the human performer moves through the multi-reality space, their shadows on the central screen become a representation of the embodied being's presence. Instead of having the robot physically move through the space, its shadow conveys its movement, challenging perceptions and imagining how the being could play and animate across realities. This transformation progresses from the robot's physical presence (in the foreground) to its shadow (artistic form) and extends to the performer's expression and beyond.

Performers, with their ability to move fluidly across the stage, provide a dynamic representation of intelligence within the narrative. Their interactions with the robot, plants with bio-signal transmission, and shadows transform the stage into a responsive environment where every entity influences and is influenced by the others.

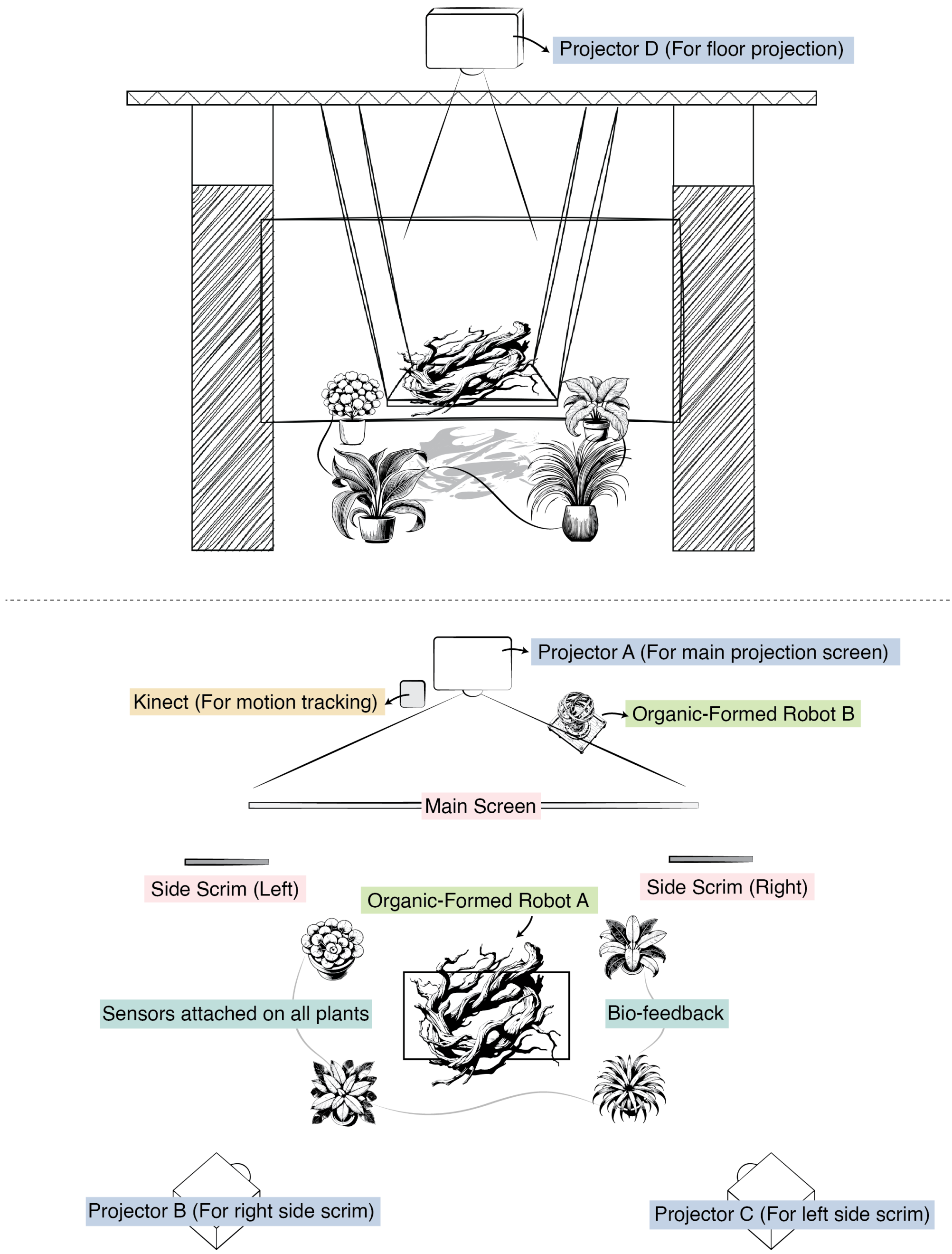
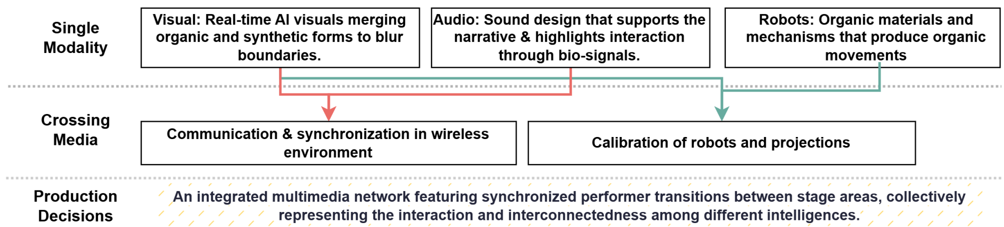
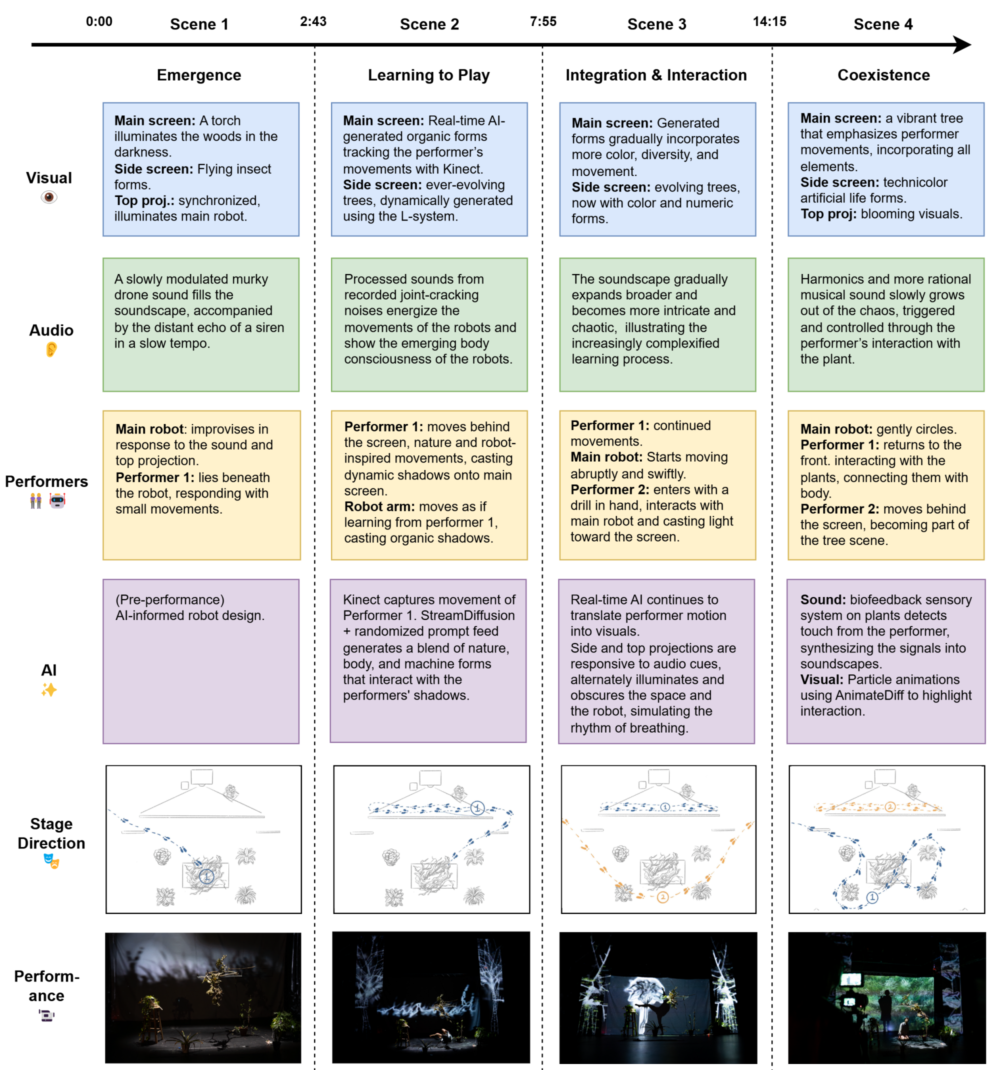


Fig. 2. Stage design diagram

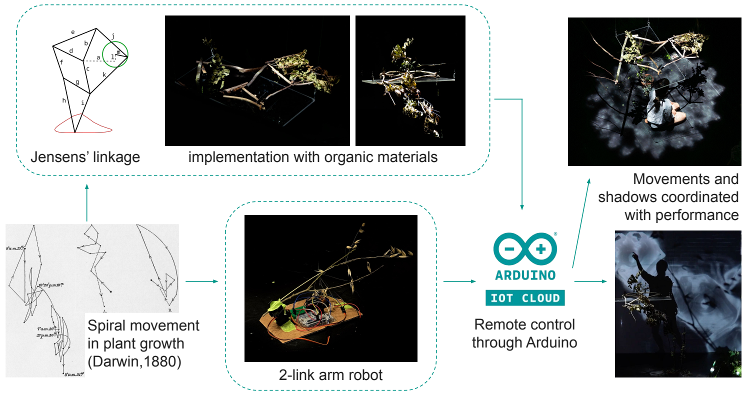


(a) System Design

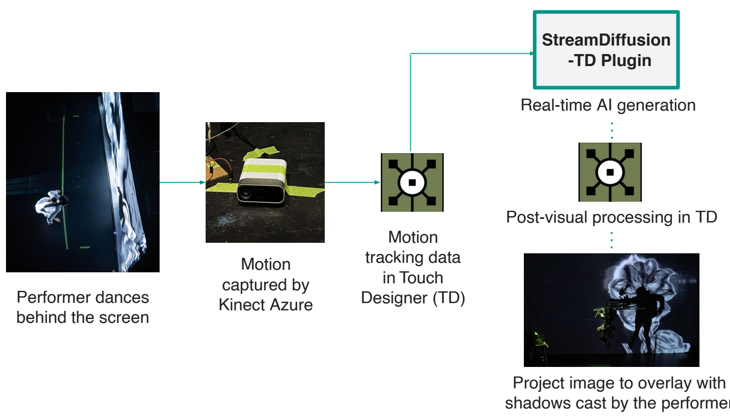


(b) A chronological overview of technical and narrative elements

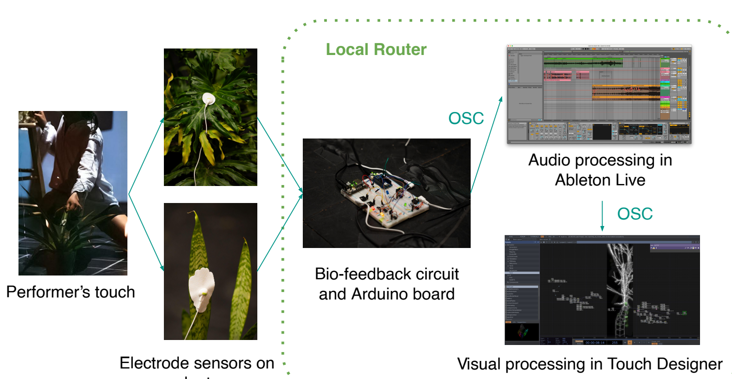
Fig. 3. System Design and Narrative Overview for our Performance



(a) Design, implementation, and effects of the found-object robots featured in the performance.



(b) Real-Time AI-Generated Imagery with Motion Tracking: the interplay of real and generated imagery



(c) Real-time Bio-feedback Data Processing: A data sonification and visualization experience created by the interaction between plants and a human performer.

Fig. 4. Diagrams for the technical workflow.

4 System Design: Representing More-than-human-intelligence

4.1 Found Object Robots

We feature two moving robots in the performance, the centerpiece robot and the shadow robot (Figure 4a). They are constructed with found natural materials, mostly fallen branches and prairie grass from our local area. The practice of building robots with improvised materials is explored in recent years as a robust and eco-friendly alternative to the status quo [Carroll and Yim 2020; Maekawa et al. 2018; Tsunoda et al. 2024].

The centerpiece robot was designed to be an artistic representation of the spiral movement of plant life's growth. The robot is made from 11 branches, connected as in the Jansen mechanism [Jansen 2007]. One link acts as the rotational input (powered by a mounted brushless motor) which is then traced into the spiraling motion of the entire linkage. Its movement is controlled by a switch synced to our performance narrative.

The shadow robot is a pan-and-tilt platform actuated by two servo motors and an Arduino-UNO-R4-WiFi. We use the actuation to create a tilting and swaying motion for the attached prairie grass, similar to their organic movements. The servos are guided by the artists remotely to echo the dancers' movements.

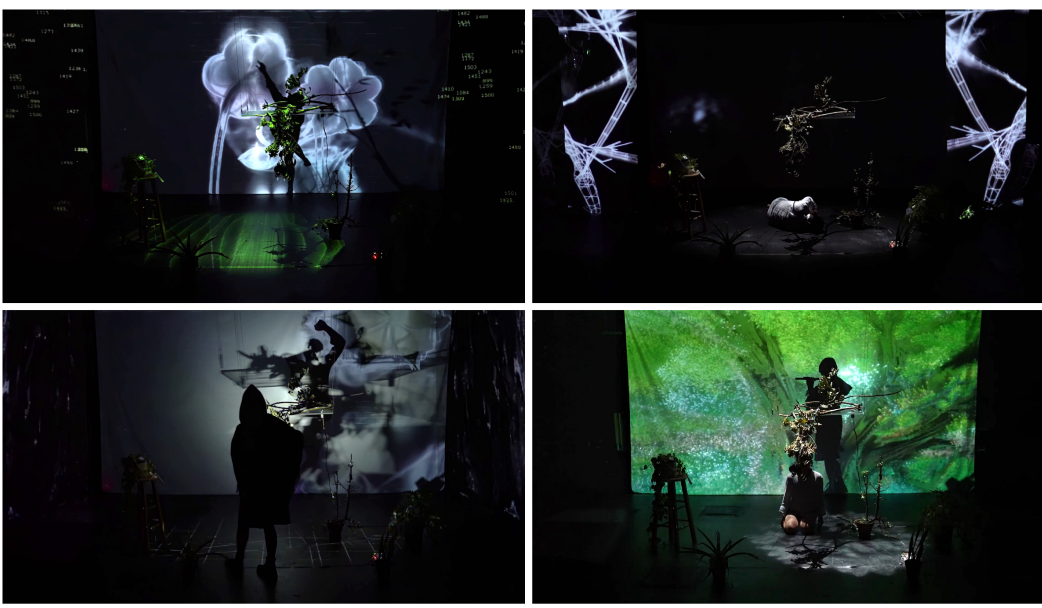
4.2 Synthetic Embodiments in Visual Design

Our visual design engages with the concept of 'the more-than-human world' by creating synthetic embodiments as representations of more-than-human intelligence, manifesting through the center, side, and top projection mappings (Figure 2). We explore three major types of synthetic embodiments:

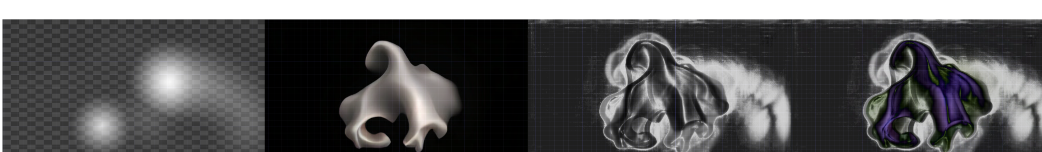
AI-generated "secondhood" with performers: In scenes 2 and 3 (Figure 3), the main screen displays live AI-generated visuals that create synthetic secondhoods of the performers. Using StreamDiffusion-TD [dotsimulate 2023; Kodaira et al. 2023], the system blends motifs of nature, human anatomy, and industrial machinery. This synthesis is guided by a curated, rotating set of prompts fed into StreamDiffusion. Real-time motion tracking from Kinect Azure drives the visuals, layering radiographic aesthetics [Marinković et al. 2012] inspired by artists like Man Ray [Ray 1921] and Nick Veasey [Veasey [n. d.]] that transition from black-and-white to color (see Figure 5b and top left of Figure 5a), inviting viewers to engage with hidden connections between natural and synthetic elements through embodied experience.

Virtual entities with authentic forms: The side scrim projection incorporates algorithmically generated tree-like forms created with the L-system framework [Lindenmayer 1968]. Inspired by natural growth processes, these forms dynamically respond to audio cues, simulating growth and adaptation, and seamlessly shift between data-driven visuals and organic aesthetics. Holographically integrated with live performers and plants in the foreground, these virtual beings construct a multisensory experience that immerses the audience in a speculative ecological narrative (see top right of Figure 5a). Additionally, the main projection showcases other virtual entities, such as the computationally simulated organic shadow that features prominently in scene 1 (see performance image in Figure 4b). In scene 4, visuals generated with TouchDesigner and AnimateDiff for ComfyUI [Kosinkadink 2024] represent the flourishing of life through dynamic, tree-like visuals (bottom right of Figure 5). These projections harmonize with the foreground's tangible elements, blending digital and physical components in a unified representation of growth and vitality.

Digital shadow with naturally cast shadow: Shadows and light are treated as coexisting forces that dissolve binary distinctions between presence and absence, the real and unreal. In scene 3, the performer's shadow overlays their AI-generated secondhood, creating an ambiguous fusion of natural and synthetic realities (see scene 2 and 3 of the Figure 4b and top left of the Figure 5a). The main robotic figure casts authentic shadows via floor projections synchronized with rhythmic audio cues, as well as the robotic arm staged behind the main screen casting shadows on the main projection. The projections create the robot's shadow and seamlessly integrate it with digital visual elements, simulating organic processes such as breathing, exploring embodiments of playfulness, or invoking cybernetic aesthetics to enhance the narrative's impact. This interplay between natural and digital shadows is further explored in a key moment in Scene 3, where the performer wields a flashlight. The light not only casts the robot's shadow but also illuminates the main screen, partially dissolving the AI-generated visuals while interacting with another performer behind the screen (see bottom left of Figure 5a). This layered interaction integrates the naturally cast shadow of the robot into the digital projection, producing a hybrid presence that embodies both tangible and intangible qualities.



(a) Performance photographs illustrating our exploration of "Synthetic Embodiments" in Visual Design



(b) A demonstration of real-time AI image generation using motion tracking data and Stream Diffusion

Fig. 5. Details of visual design

4.3 Bio-Signal Synthesis in Sound Design

The electroacoustic soundscape that persists throughout the performance incorporates both human and inhuman elements, echoing the theme of the performance and the ideas behind the visual design. In scene 4, we incorporate an interactive bio-feedback sensory system to further strengthen the connection between the staging, performance, and soundscape. The sound design actively integrates with stage design and narrative performance, going beyond the acoustic realm to create an immersive auditory experience.

Embodied field recording: The composition for the performance intentionally includes real-world sonic elements from our building process. The field recordings include cracking sounds of body joints and spine, sounds of walking on grass, and sounds of operating drills captured when the robot was built, etc. The recordings are processed digitally, adding cross-layer modulations accomplished through innovative spectral crossing, and accompanied by a vibrant electronic layer made mainly with the synthesizer Arp 2600. Contextualized into the performance narrative, the sounds from the natural world weave an expressive soundscape that evokes the vibrancy and interconnection among human, nature, and machines.

Bio-Signal sonification: Biofeedback is a concept from medicine and psychology, where the body learns to regulate itself using feedback from signals generated by its own physiological processes. As the core insight of biofeedback - that the biological entity is also a learning system [West 2009] - is a perfect demonstration of the thesis of our piece, we integrate biofeedback as an artistic element into our performance. We use electromyography (EMG) sensors to capture the feeble electrical activity beneath the biological surfaces to which they are attached. As shown in Figure 4c, we attach electrode pads to the leaves and branches of the plants on stage. These electrical spikes are converted by circuit [Wright et al. 1997], then read by an Arduino MKR WiFi board and transmitted to the audio and visual programs via OSC. In the final scene of the live performance, the performer makes physical contact with the plants, initiating the transmission of bio-information. That bio-data triggers real-time processing in sound that transforms a chaotic soundscape to a harmonious texture that leads the performance to a harmonious conclusion.

5 Audience Feedback and Future Direction

We conducted the performance twice for audiences of 30 people each and once in video format for an audience of 60. Attendees praised the immersive experience, describing it as "incredible" and "a vibrant concept." One viewer highlighted, "My favorite part … that's an actual recording of cracking knuckles synced in real time to the dancer's movements!" Many reflected on how the performance prompted them to rethink their relationship with technology, particularly AI, through its themes of interconnectedness.

The interdisciplinary collaboration across Visual Arts, Music, and Computer Science sparked interest, with questions about how dancers, audiovisual systems, and robots were integrated seamlessly. The technical complexity of synchronizing these real-time elements was widely admired. Encouragingly, we received requests to present this work at K-12 STEM outreach events, with organizers highlighting the project's environmentally conscious concept and human-in-the-loop art-making process as particularly inspiring for students.

We propose two directions to further develop our piece. Firstly, some audiences have found our work to be "too abstract". We acknowledge the ambiguity in our presentation, but want to preserve the open-ended and provocative nature of our piece. Nevertheless, to clarify the narrative and concept, we will include pre-show voiceovers and supplementary text. Secondly, we were stopped by technical challenges of doing reinforcement learning with the organic-form robots we built, and opted for teleoperation. In the future, we will improve the hardware and software of the robot to present the learning process on state, further aligning with the work's themes of co-creativity and more-than-human intelligence.

6 Conclusion

Learning to Move, Learning to Play, Learning to Animate positions performance art as a critical medium for interrogating agency and intelligence in an age where AI and ecological systems are redefining creativity. By bringing together visual art, ecology, robotics, music, biofeedback, and artificial intelligence, this work treats interdisciplinarity as both method and message, presenting a living system of co-creation that challenges anthropocentrism and expands our understanding of agency and participation.

Looking toward the future, our project stands as both artistic practice and provocation, exploring how co-creative agency can take shape among humans, machines, and the more-than-human world. In a time marked by rapid technological change and ecological uncertainty, this work invites a critical perspective that recognizes ongoing interdependence across disciplines, domains, and entities, seeks new pathways for learning and making with more-than-human intelligence, and foregrounds empathy and ethical engagement. In doing so, it extends the practice of co-creation far beyond the stage and into the fabric of our interconnected everyday lives.

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