Nature Mobility: Autonomous Archives and Environmental Memory

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Abstract

Nature Mobility: Autonomous Archives and Environmental Memory

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This dissertation investigates how autonomous robotics, generative systems, and environmental data visualization can function as mobile archives of ecological memory through public encounter and autonomous movement. Responding to climate change, environmental instability, and the increasing separation between urban life and natural ecosystems, the project explores alternative forms of preservation beyond static archives and conventional exhibition spaces.

The dissertation centers on *Nature Mobility*, an artistic robotics project in which an autonomous robot navigates public urban environments while carrying sculptural elements and generative videos created from ecological datasets collected in 2025.

These data include salmon population data, weather data such as humidity, air pressure, temperature, wind speed, precipitation, cloud cover, sunrise and sunset times, forest health indices, bird migration intensity, wildfire activity, and whale population records. Using ROS2 based navigation, SLAM, sensor fusion, and TouchDesigner, environmental data is translated into abstract visual systems intended as speculative encodings of ecological conditions rather than literal representations of nature. The robot also engages in AI generated communication with both human and nonhuman entities, producing fragmented and occasionally awkward interactions that challenge conventional expectations of social robotics and technological efficiency.

This project has been performed as a public robotic intervention at several Seattle locations, including the Seattle Center, Olympic Sculpture Park, the University of Washington and Green Lake Park. Evaluation is conducted through qualitative observation of audience interaction, interpretive response, and behavioral unpredictability during live encounters. Through this approach, the dissertation examines how autonomous systems, environmental data can function within public space as mobile archives carrying ecological memory across uncertain environmental futures.

Acknowledgement

I would like to express my sincere gratitude to the DXARTS community and the University of Washington for supporting me throughout this journey. Before joining DXARTS, I was uncertain about my future as an artist. Pursuing a Ph.D. in DXARTS allowed me to continue my artistic practice, grow as a researcher, and imagine new possibilities for my work and life. I am deeply grateful for the support and community that made this experience possible.

I am especially grateful to my advisor, Tivon Rice, for his guidance, support, and encouragement throughout my years in DXARTS. His thoughtful feedback continually challenged me to expand my thinking and approach my work from diverse perspectives. His mentorship has had a profound impact on my artistic practice and professional development.

My sincere thanks go to the DXARTS faculty and my committee members, Juan Pampin, Afroditi Psarra, and Laura Luna Castillo, for their support, encouragement, and contributions to my artistic practice throughout my years in DXARTS.

I would also like to thank Prof. Henry Jackson-Spieker for the opportunity to work at CMA, and Prof. Sep Makhsous for welcoming me into his ECE lab, where I developed and completed two robotic art projects.

I am grateful to the undergraduate researchers who contributed to these projects: Thomas Glass, Aakash Namboodiri, Jimena Guzman, Joydeep Saha, Tanya Prihar, Christoph Heller, and Andy Cai. Their dedication, creativity, and technical expertise made this work possible.

Finally, I would like to thank my peers in DXARTS. Their friendship, feedback, and support enriched my experience both academically and personally, and I will always cherish the memories we created together.

Dedication

사랑하는 남편 김경진과 언제나 그리운 스칼렛, 존경하는 부모님 전용임, 최영철, 고마운 이모들 전용미, 전용숙께.

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Figure 1. 3D modeling capture of Nature Mobility.

Can we imagine what nature will look like one hundred years from now? If the end of the world were approaching, how would nature survive, and in what form might it remain? As climate change continues to reshape ecosystems across the globe, it has become increasingly uncertain whether the natural environments we recognize today will continue to exist in the coming decades.

This project stems from my cultural background and lived experience. My relationship to nature has always been shaped by forces beyond my control. In Korea, everyday life unfolded under the shadow of a divided nation and a proxy war that claimed millions of lives. The consequences of war devastated both cities and landscapes, while rapid industrialization and urban development continuously transformed the environment. Today, nearly eighty percent of the country is urbanized.

When my family built a new house in 2006, it stood for only a few years before being demolished under a government led redevelopment plan. We were forced to relocate, and apartment buildings soon replaced the home my parents had lived in for more than twenty years. The erasure of the house was not only the removal of a physical structure, but also the disappearance of memory, attachment, and continuity.

My hometown is located near the western sea, where my mother spent her childhood before moving to Seoul. During the dictatorship of the 1960s - 1970s, the government constructed a large sea wall project that transformed the surrounding environment into an artificial lake. When my mother later returned, the ocean and landscape she remembered no longer existed. The place survived only through stories, photographs, and fragmented memory.

Through these experiences, I came to understand how environmental space, personal memory, and political power are deeply intertwined. Homes, landscapes, and ecosystems can be erased, reconstructed, or overwritten by forces operating beyond individual control. Environmental change is therefore not only an ecological issue, but also a question of memory, disappearance, and historical continuity.

Historically, artists have attempted to preserve and interpret environmental experience through representation and technological mediation. The English Romantic painter J. M. W. Turner[1] captured unstable atmospheres, turbulent oceans, and shifting light conditions that continue to communicate environmental sensation long after their original moment disappeared. Later media artists such as Nam June Paik expanded the relationship between technology, transmission, and public encounter through television, radio, and networked communication systems. In works such as TV Garden, Paik [2]positioned electronic media systems within dense natural environments, allowing television monitors, plants, and moving images to coexist within hybrid ecological spaces. Rather than separating nature and technology into opposing systems, Paik's installations explored how environmental experience could be shaped through technological mediation and electronic image systems. Today, photography, sensing technologies, video, and digital storage provide unprecedented tools for recording environmental change. Yet these archives remain fragile, dependent upon infrastructures that may not survive technological failure, war, ecological collapse, or long term environmental instability.

[1] J. M. W. Turner, https://www.nga.gov/artists/1939-joseph-mallord-william-turner
[2] TV Garden, Nam June Paik, https://www.guggenheim.org/artwork/9537

Figure 2. "Calais Pier", J. M. W. Turner, 1803. Oil on canvas. Image courtesy of The National Gallery, London. Public domain.

Figure 3. "TV Garden" , Nam June Paik, 1974 (2000 version).

This dissertation investigates how autonomous robotics, generative systems, and environmental data visualization can function as alternative forms of ecological remembrance through movement, public interaction, and embodied presence. Rather than treating archives as fixed systems of storage, I became interested in mobility itself as a form of preservation. This perspective aligns with discussions presented in *Re-collection: Art, New Media, and Social Memory*, which argue that cultural memory survives not only through archival preservation but also through processes of migration, transmission, emulation, and reinterpretation. In this framework, memory is not understood as a stable object secured within institutional archives, but as an active and continually evolving process that moves across media, locations, and social contexts. Cultural memory persists precisely because it is repeatedly translated, circulated, and reactivated through new forms of encounter.[3]

Nature Mobility extends this understanding toward environmental memory. Rather than relying solely on static archives or institutional preservation, the project proposes that autonomous robotic systems can function as mobile carriers of ecological memory. As the robot moves through public space, environmental information is continually recontextualized through technological mediation, public interaction, and changing environmental conditions. In this way, ecological memory remains active not by remaining unchanged, but through ongoing movement, circulation, and reinterpretation across time and space.

[3] Rinehart, R., & Ippolito, J. *Re-collection: Art, New Media, and Social Memory*. The MIT Press, 2014.

The dissertation centers on *Nature Mobility*, an artistic robotics project in which an autonomous robot navigates urban environments while carrying sculptural elements and generative visual systems derived from environmental datasets collected in 2025, including salmon population data from the Pacific Northwest. Using ROS2 based navigation(Nav2), SLAM, sensor fusion, and TouchDesigner, ecological data is translated into abstract visual patterns, movement, and atmospheric imagery rather than literal representations of nature. These visual systems function as speculative encodings of environmental conditions intended for uncertain future interpretation.

The robot also engages in autonomous social behaviors through AI generated communication systems that interact with both human and nonhuman entities encountered in public space. Fragmented dialogue, tonal shifts, hesitation, awkwardness, and communication failure are intentionally incorporated into the behavioral structure of the project. Through humor, absurdity, and performative instability, the work challenges expectations of technological efficiency and instead positions the robot as a vulnerable carrier of ecological memory. *Nature Mobility* has been performed as a public robotic intervention at Seattle Center, Olympic Sculpture Park, the University of Washington and Green Lake Park where audience encounters, confusion, curiosity, and interaction became central components of the work itself.

This dissertation contributes to artistic robotics, socially engaged media art, and environmental art by reframing autonomous robots as performative ecological archives rather than service oriented machines. It argues that environmental memory can be transmitted not only through stable representation and preservation, but also through unstable encounters, speculative communication, behavioral presence, and public movement.

Chapter 1 examines earlier artistic projects and theoretical frameworks surrounding archives, absurdity, AI narratives, and performative robotics that informed the development of *Nature Mobility*.

Chapter 2 analyzes the robotic systems, environmental data visualization, autonomous navigation, and public interactions that structure *Nature Mobility*.

Chapter 3 explores material experiments and environmental residue as alternative forms of ecological inscription and memory preservation.

Chapter 4 This chapter reflects on public encounters, technical instability, and the broader implications of artistic robotics as mobile ecological archives.

Chapter 1: Memory, Absurdity, and Alternative Archives

1.1 Preservation as Encounter

Sculptural installations often do not remain in their original form after an exhibition ends. Once dismantled, many installations survive only through documentation, photographs, or fragmented records. While documentation may preserve visual information about the work, it rarely preserves spatial encounter, audience interaction, temporality, or the embodied experience of moving through an installation. This condition raises questions about how artworks might continue to exist beyond temporary exhibition spaces and whether preservation can occur through forms other than static physical display.

My earlier practice explored alternative forms of circulation through zines, websites, and distributed media platforms. Rather than treating exhibitions as singular and fixed events, these projects investigated how artworks could persist through repetition, circulation, and public accessibility. I became increasingly interested in how artistic experiences might continue beyond institutional space through movement across platforms, audiences, and locations.

This shift away from fixed exhibition structures connects to discussions of site specificity developed by Curator and art history educator Miwon Kwon in *One Place After Another*, where she argues that “the site is now structured (inter)textually rather than spatially.” In this framework, the site no longer exists as a singular physical location, but emerges through circulation, mediation, and social relations. Foundational media artists such as Nam June Paik similarly challenged fixed spectatorship through broadcast systems, television, and networked media transmission, allowing artworks to circulate beyond the physical boundaries of gallery space.[4]

Fiugre 4. Still from "Orwell / Sapho", Nam June Paik, 1984.

These ideas strongly informed projects such as *Lab for Fake Labor*, which originally existed as a room installation but later continued through an accompanying website and printed zine. Rather than functioning as secondary documentation, these formats became extensions of the work itself. The project remained accessible after the

[4] Nam June Paik, *We Are in Open Circuits: Writings by Nam June Paik*, ed. John G. Hanhardt, Gregory Zinman, and Edith Decker-Phillips (Cambridge, MA: MIT Press, 2019).

exhibition ended, allowing audiences to encounter it through distributed and repeatable forms rather than a singular site specific installation.

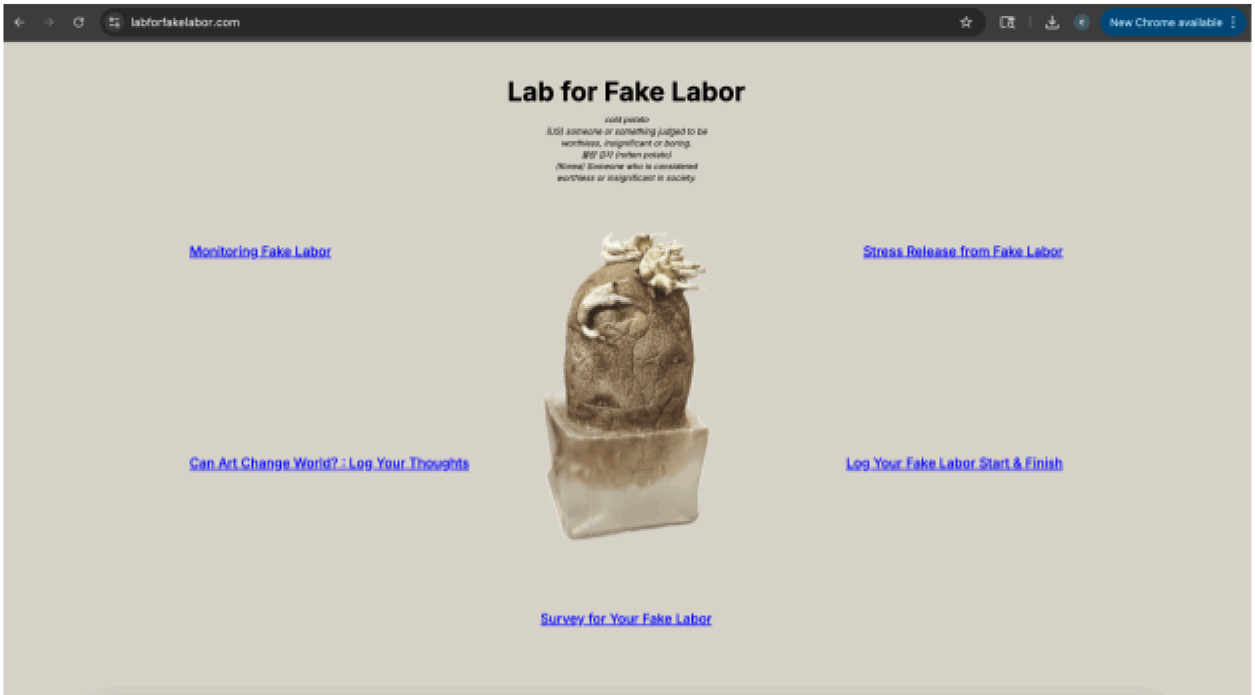

Figure 5. Website screenshot from "Lab for Fake Labor", 2025.

Figure 6. Zine "Double Shift" by "Lab for Fake Labor", 2026.

A similar investigation into expanded circulation appeared in *Panic Room* (2026), presented at Vestibule Gallery by my artist collective team, Jeju Island Artist Collective. For the exhibition, I developed an RPG style game that incorporated a virtual map of the gallery installation. Although the physical exhibition was later dismantled, the online game remained accessible after the show ended, allowing audiences to revisit and navigate the exhibition through a digital environment. Rather than existing solely within the temporal limits of gallery installation, the project extended into an ongoing interactive platform circulating beyond the physical exhibition space.

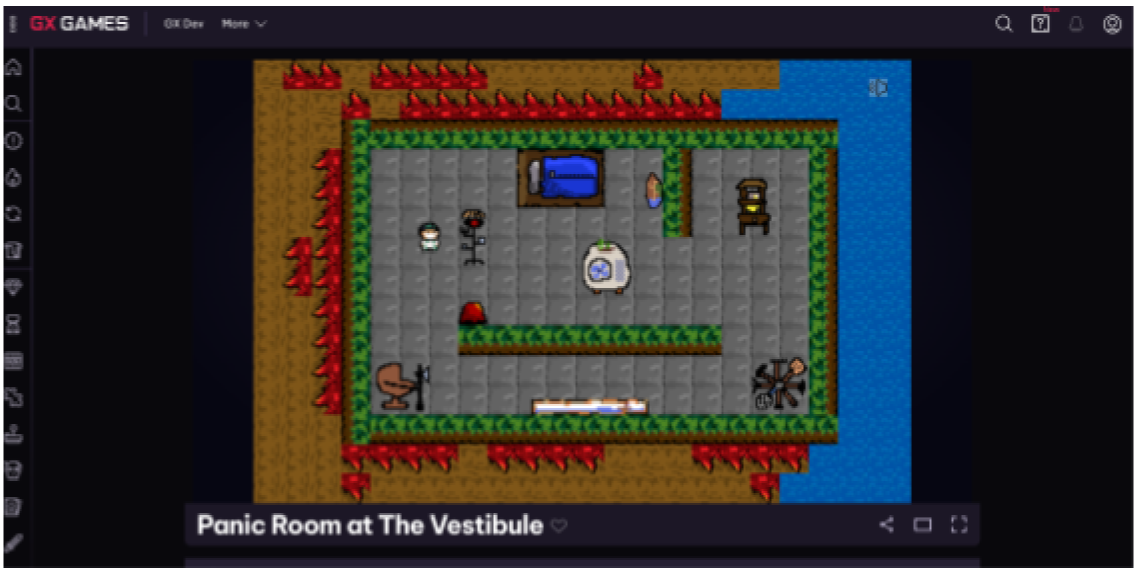

Figure 7. Screenshot from the RPG game developed for "Panic Room", Jeju Island Artist Collective, 2026.

Through these experiments, I gradually became interested in mobility itself as a form of preservation. As environmental instability and ecological disappearance became increasingly central within my practice, I began questioning whether archives could operate not only through storage and documentation, but also through movement, behavioral interaction, and public circulation. Rather than preserving ecological memory as a fixed historical record, I became interested in how memory might remain active through repeated encounters within changing environments.

These investigations later became foundational to *Nature Mobility*. Instead of existing as a static installation within institutional space, the project adopts wandering, livestreaming, public interaction, and technological transmission as core components of its archival structure. Mobility therefore operates not simply as transportation, but as a mode of encounter through which environmental memory continues to circulate within public space.

1.2 Absurdity and Collective Anxiety

Absurdity, awkwardness, repetition, and humor operate as central strategies throughout my artistic practice. Rather than using humor as simple entertainment or comic relief, I approach absurdity as a method for questioning reality, destabilizing familiarity, and exposing tensions embedded within social, political, technological, and environmental systems. Repetition, behavioral instability, and awkward interaction frequently appear throughout my work as performative conditions that generate discomfort, anxiety, and uncertainty within seemingly familiar situations. Humor therefore operates less as resolution and more as a mechanism that reveals instability, contradiction, and psychological tension embedded within everyday life.

My work often reconstructs fragments of the past, observations of the present, and speculative visions of the future through surreal environments, unstable behaviors, and fictional systems. Rather than presenting coherent narratives or stable technological systems, these projects frequently produce fragmented experiences in which mechanical behavior, environmental instability, emotional discomfort, and fictional scenarios overlap. Through these fragmented conditions, absurdity becomes a strategy for examining the tensions between technological systems, historical memory, and social behavior.

Projects such as *Voice of God*, *Cuckoo, Puckuck*, and *Mouseness* explore how memory, anxiety, social uncertainty, and technological systems can become intertwined through performative installations, AI generated narratives, robotic behavior, and public interaction. These recurring themes later became foundational to my investigations into ecological memory, performative robotics, and speculative archival systems throughout this dissertation.

In earlier projects such as *I Feel an Earthquake Everyday* (2017), I explored unstable psychological and environmental conditions through room scale installations, repetitive mechanical movement, wall based drawing systems, and fictional video environments. The project reflected both physical instability and psychological anxiety by reconstructing childhood memories through resonant objects, unstable movement, and speculative animated imagery. Through these fictional environments, I examined how personal memory, environmental tension, and emotional instability could become intertwined within immersive spatial experiences.

Figure 8. I feel an earthquake everyday at Hunter Project Space, 2017.

Unlike historical Surrealism, which frequently emphasized dreams and the unconscious, my work focuses more directly on the instability of lived reality and the anxieties produced by contemporary social conditions.

Contemporary humor increasingly operates through irony, discomfort, and black humor rather than playful absurdity alone. Artists often employ humor not to resolve tension, but to intensify contradiction and expose underlying structures of anxiety and uncertainty. Within my own practice, absurdity frequently emerges through unstable behaviors, repetitive systems, and awkward interactions between bodies, machines, sound, and environments.

I draw particular inspiration from artists such as Peter Fischli and David Weiss, whose work *The Way Things Go* (1987) [5]constructs a continuous chain reaction in which ordinary objects appear to misbehave and detach from their intended functions. Their

[5] Millar, Jeremy. *Fischli and Weiss: The Way Things Go*. London: Afterall Books, 2009.

work transforms malfunction, instability, and behavioral deviation into humor while simultaneously revealing the absurdity embedded within everyday systems. This idea of “misbehavior” strongly informs my own practice, particularly in projects involving robotics and autonomous systems, where unstable movement and behavioral unpredictability become performative conditions rather than technical flaws.

Figure 9. “The Way Things Go”, Peter Fischli and David Weiss, 1987.

My projects such as *Cuckoo, Puckuck* and the robotic mouse project – *Mouseness* – extend these ideas through repetition, discomfort, and mechanical behavior. *Cuckoo, Puckuck* transforms the familiar domestic object of the cuckoo clock into an overwhelming and chaotic installation in which repetitive sound, synchronized movement, and exaggerated vocalization generate both humor and anxiety. Rooted in personal memory and broader Korean social history, the work reflects tensions surrounding rapid modernization, domestic pressure, and psychological instability.

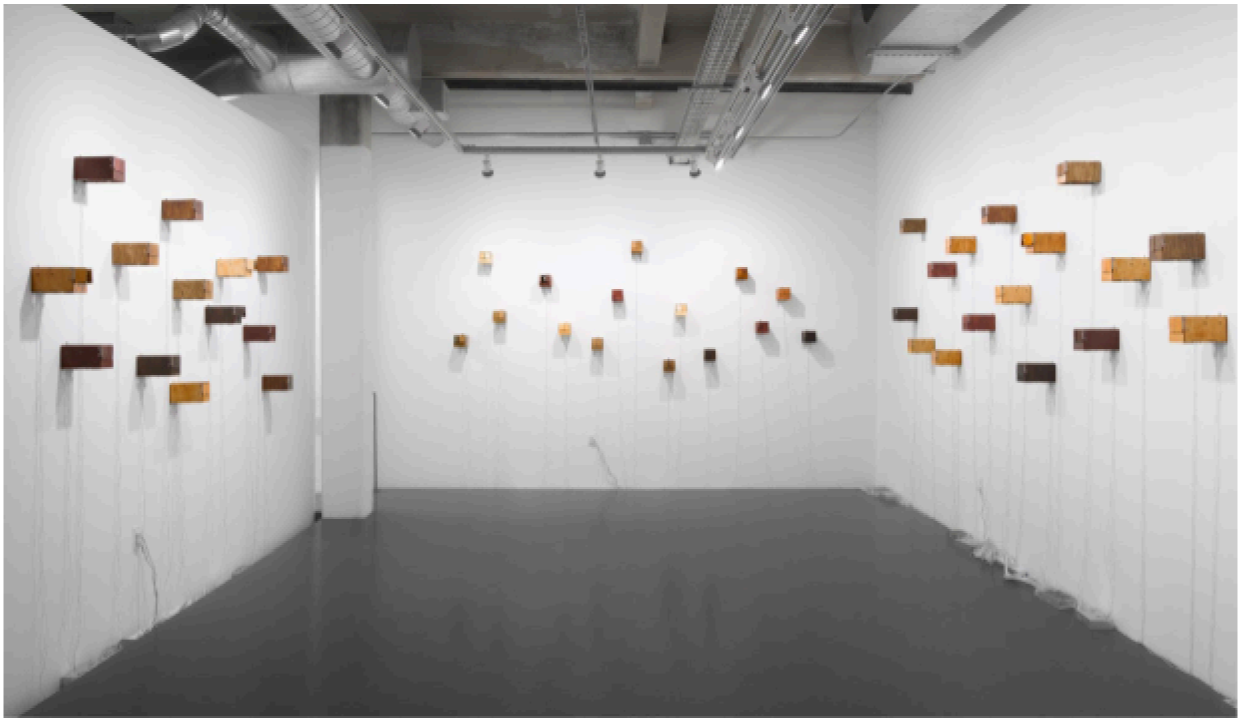

Figure 10. "Cuckoo, Puckuck" at 4 culture gallery, 2023.

Figure 11. "Cuckoo, Puckuck" at 4 culture gallery, 2023.

Similarly, the robotic mouse project employs small autonomous robotic creatures whose movements evoke vulnerability, contamination, fear, and survival. The awkward and unstable behavior of these systems produces emotional ambiguity in which viewers may simultaneously experience curiosity, discomfort, empathy, and unease. Rather than

behaving as efficient technological tools, the robots hesitated, hid within dark corners, and reacted unpredictably to human presence, producing an atmosphere oscillating between empathy, discomfort, and dark humor.

Figure 12. "Mouseness" at DXARTS gallery, 2025.

Figure 13. "Mouseness" at DXARTS gallery, 2025.

The work of Korean artist Jung Yeondoo also informs my understanding of layered spectatorship and absurdity. His staged environments often combine humor and artificiality with underlying reflections on identity, labor, memory, and cultural hybridity. This layering strongly resonates with my own interest in constructing works that remain visually accessible while simultaneously containing historical, political, and emotional complexity. Like many of my own installations, his works operate through staged absurdity that initially appears playful or artificial while gradually revealing psychological and social tension.

Figure 14. Borame Dance Hall, Jung Yeondoo, 2001.

Across these projects, absurdity functions not as an escape from reality, but as a strategy for confronting instability, contradiction, and collective anxiety. Humor becomes a mechanism through which technological systems, environmental uncertainty, and social behavior can be reexamined through discomfort, interruption, and unexpected encounter. These investigations later became central to *Nature Mobility*, where awkward robotic behavior, fragmented AI communication, and performative instability resist expectations of technological smoothness, efficiency, and predictability.

1.3 AI Narratives and Speculative Memory

As part of my practice in DXARTS 482: Data Driven Art II, I explored how AI could function as an artistic tool and how data could be translated into visual and performative forms using technologies such as GPT-2, GPT-3, text generation systems, image and video generation systems, and voice cloning trained on my own datasets. Developed within this course, *Voice of God* (2022) examined how AI generated narratives, synthetic voice, and fragmented storytelling systems could reconstruct and reinterpret personal and historical memory. The project originated from a traumatic childhood experience in which I witnessed my grandmother speaking in tongues late at night. This unsettling moment later led me to question her deep attachment to Christianity and the church. As I investigated this experience further, I uncovered a family history shaped by separation, displacement, and trauma during the Korean War.

To reconstruct this narrative, I created an immersive installation combining AI generated systems, zines, sound, websites, animation, and kinetic sculpture. An auto typing website continuously generated text in real time, while synthetic voices trained from elderly female vocal recordings recreated an uncanny vocal atmosphere that echoed my childhood memories. A printed zine displayed within a church pew rack extended the narrative into a physical and participatory form, encouraging viewers to encounter the work through both reading and spatial interaction.

At the center of the installation, projected animation reflected across the surface of water while kinetic sculpture introduced unstable movement and shifting light throughout the space. The reflections distorted and fragmented the projected imagery, producing a visual atmosphere that mirrored the instability and fluidity of memory itself. Rather than reconstructing memory as factual history, the installation focused on emotional atmosphere, psychological tension, and mediated remembrance.

Within *Voice of God*, AI generated systems did not function as tools for accurate reproduction, but as mechanisms for reconstructing emotional uncertainty and fragmented historical experience. Synthetic speech, generative text, and nonlinear narrative structures continuously reshaped the relationship between memory, storytelling, and technological mediation. The project explored how machine generated systems might produce unstable forms of remembrance that move between personal trauma, collective history, and speculative reconstruction.

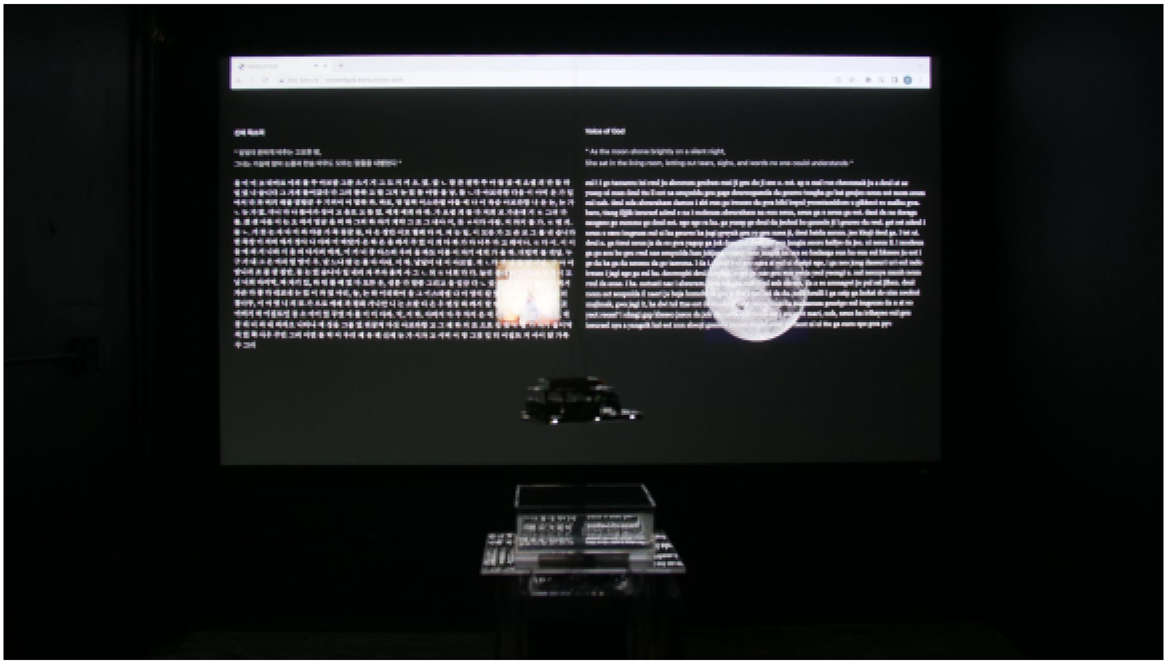

Figure 15. "Voice of God" at DXARTS gallery, 2022.

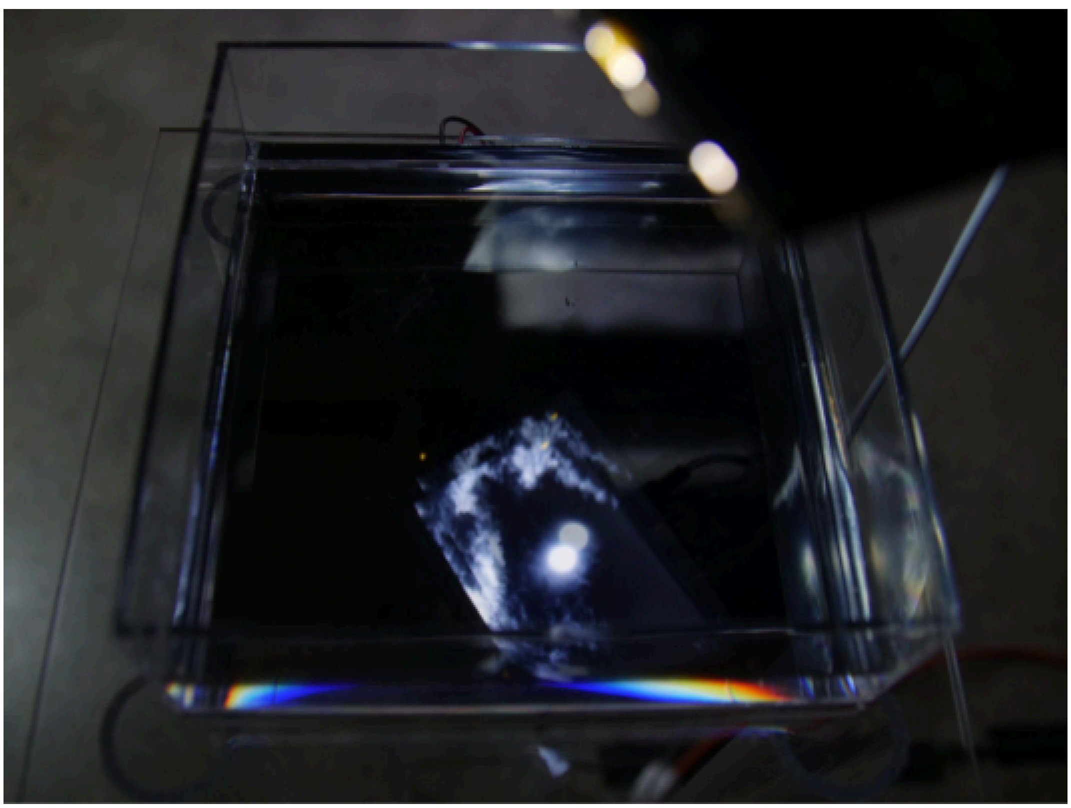

Figure 16. "Voice of God" at DXARTS gallery, 2022.

This investigation later informed my understanding of speculative memory: a form of historical transmission shaped through incomplete records, machine generated interpretation, mediated experience, and nonlinear narrative structures. Rather than preserving memory as fixed documentation, speculative memory allows narratives to remain unstable, layered, and open to reinterpretation across time.

These ideas later became central to *Nature Mobility*. While *Voice of God* reconstructed fragmented memories of family history and war through AI generated storytelling systems, *Nature Mobility* extends this approach toward ecological memory and future environmental preservation. The robot speculates on how environmental conditions from 2025 may one day survive through encoded visual systems, autonomous behavior, and machine mediated archives. In both projects, AI and generative systems operate not simply as technical tools, but as narrative agents that reshape how memory, history, and future interpretation are constructed and experienced.

1.4 The Robot as a Performative Witness

Robots are often designed and understood through frameworks of productivity, optimization, automation, and efficiency. Within industrial and commercial contexts, robotic systems are expected to perform tasks with precision while minimizing unpredictability, hesitation, or behavioral instability. Social robotics similarly tends to prioritize assistance, service, and seamless interaction between humans and machines through technologies such as Siri, Alexa, companion robots, and customer service robotics. In contrast, my practice investigates alternative roles for robotics that emphasize vulnerability, awkwardness, uncertainty, and performative encounter rather than functional efficiency.

Rather than approaching the robot as a tool that simply executes commands, I examine robotics as a behavioral and narrative medium capable of producing emotional, spatial, and social experiences within public environments. Movement, hesitation, instability, repetition, and communication failure become performative conditions rather than technical problems to eliminate. Through these behaviors, the robot operates less as a machine designed for productivity and more as an unstable presence navigating social and environmental space.

This approach connects to artistic robotics practices that challenge conventional assumptions surrounding machine intelligence and autonomous systems. Artist and theorist Simon Penny has extensively examined embodied interaction, responsive environments, and the relationship between humans and autonomous technological systems within media art and digital culture. Works such as *Petit Mal* (1993) presented robotic movement as uncertain, improvisational, and behaviorally expressive rather than task oriented. Rather than functioning as efficient technological tools, Penny's robotic systems emphasized instability, responsiveness, and performative interaction within shared space.[6]

Similarly, projects by Šašo Sedlaček[7] often employ dysfunctional or socially awkward technological systems that reveal anxieties surrounding labor, dependency, and

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[6] Simon Penny," Petit Mal", https://simonpenny.net/works/petitmal.html
[7] Sedlaček, Sašo. "Beggar Robot." https://sasosedlacek.com/beggar-robot/.

technological infrastructure. These artistic practices reposition robotics away from industrial functionality and toward performative and socially reflective roles.

Figure 17. "Petit Mal", Simon Penny, 2026.

Figure 18. Beggar Robot, Šašo Sedlaček, 2006.

Within my own projects, robotic systems frequently appear fragile, hesitant, or emotionally ambiguous. The robotic mouse project, for example, used small autonomous robotic creatures whose unstable movement generated simultaneous feelings of empathy, discomfort, and vulnerability. Rather than behaving as efficient technological systems, the robots appeared anxious, reactive, and uncertain within their environment. This instability allowed the robotic body to function as a carrier of psychological and historical tension rather than a purely technical apparatus.

Through these investigations, I began to understand robotic behavior as a form of performative witnessing. The robot does not simply document or represent memory, but physically moves through environments while carrying historical, emotional, and ecological traces. Witnessing therefore emerges not through stable narration or factual accuracy, but through behavioral presence, interruption, repetition, and public encounter.

This framework later became central to *Nature Mobility*, where the robot operates as a wandering ecological archive moving through urban space. Its hesitant navigation, fragmented AI communication, and awkward social interactions position the machine not as an authoritative technological system, but as a vulnerable witness attempting to carry environmental memory within conditions of uncertainty, disappearance, and environmental transformation.

Chapter 2: Nature Mobility and Ecological Encoding

2.1 The Practice of Speculative Encoding

Nature Mobility transforms ecological datasets collected throughout Seattle and the Pacific Northwest in 2025 into generative visual environments using TouchDesigner. These datasets include environmental measurements, salmon population counts, whale appearance records, wildfire activity, and bird migration data. Rather than approaching visualization as a scientific or informational tool, I use these datasets as material for generative image construction and speculative environmental encoding.

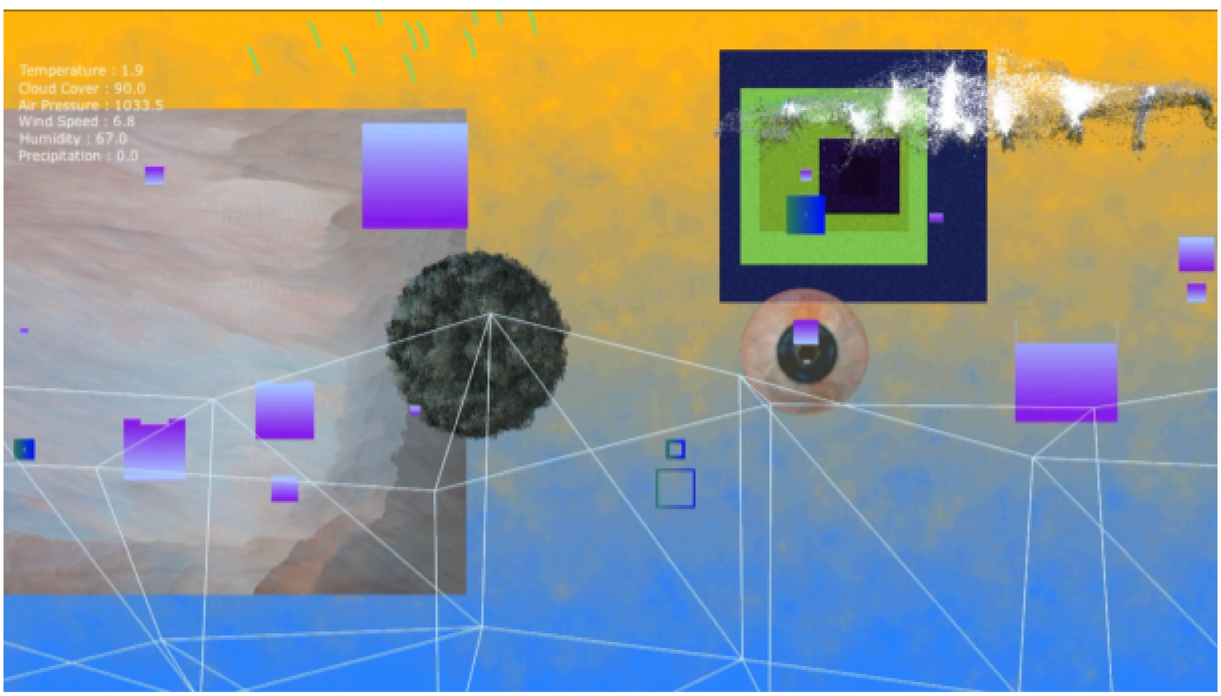

Figure 19. Screenshot from Nature Mobility Video II , 2026.

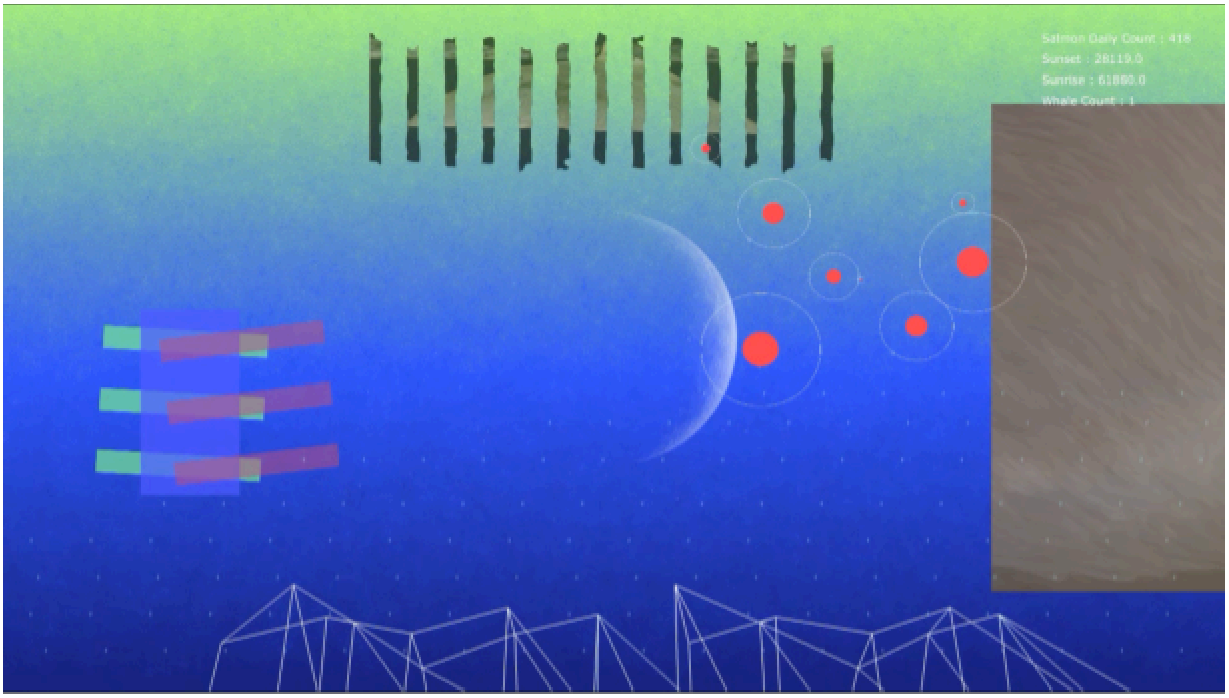

Figure 20. Screenshot from Nature Mobility Video I, 2026.

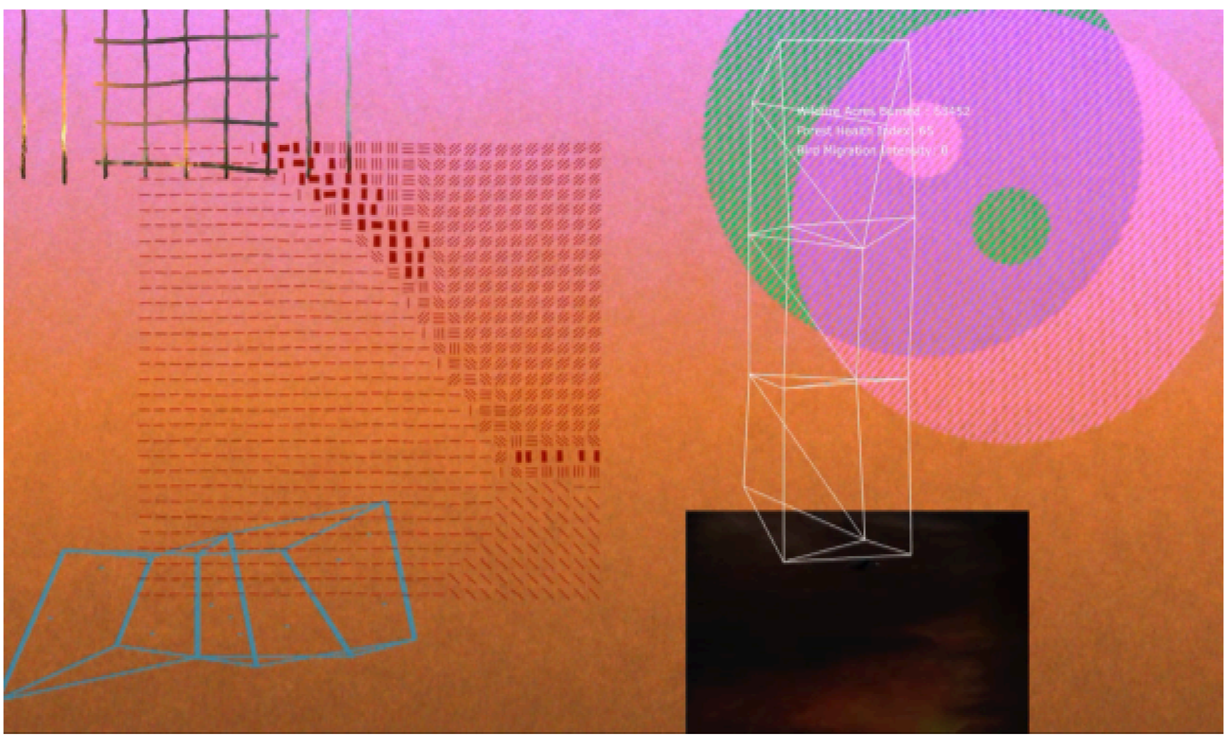

Figure 21. Screenshot from Nature Mobility Video III , 2026.

Throughout the development of these videos, I remained skeptical of the seductive aesthetics often associated with generative media systems. While TouchDesigner can produce immersive and visually compelling imagery, I questioned whether these visuals could meaningfully communicate ecological conditions rather than simply aestheticizing environmental data. This tension led me away from producing singular decorative styles and toward constructing unstable image systems that resist immediate readability while still carrying ecological information.

The project therefore approaches abstraction not as direct representation, but as a speculative form of environmental transmission. Ecological data is translated into shifting color systems, atmospheric distortion, geometry instancing, particle movement, visual density, and generative motion rather than documentary imagery. Certain datasets produce subtle visual changes, while others generate abrupt interruptions, noise, fragmentation, or accumulation within the image. Salmon population data, for example, influences instanced geometric formations and movement behaviors, while wildfire data introduces atmospheric density, color shifts, and visual instability across the screen space.

The abstract videos also incorporate gradual color transitions shaped through continuously changing environmental datasets. These investigations into color relationships were informed in part by Josef Albers's *Interaction of Color*, which examined how color perception continuously shifts depending on surrounding chromatic conditions.[8] Within *Nature Mobility*, color similarly operates as a relational and unstable

[8] Albers, Josef. *Interaction of Color*. Revised and Expanded Edition. New Haven: Yale University Press, 2013.

condition rather than a fixed visual property. Environmental changes and fluctuating datasets continuously reshape the atmosphere of the generative imagery, producing shifting perceptual relationships across the screen space. Through these transitions, the visuals suggest how ecological perception and environmental memory may themselves remain unstable and continuously altered by surrounding conditions.

Figure 22. "Interaction of Color", Josef Albers, 1963.

These generative systems intentionally remain partially ambiguous. The visuals operate somewhere between environmental record, machine language, and atmospheric artifact. Rather than presenting nature as stable documentation, the project produces unstable visual traces shaped through translation, abstraction, and technological mediation.

This approach emerged from a broader speculative question within the project: if the robot were to survive hundreds or thousands of years into the future, who or what would eventually encounter these archives? Human language, institutions, and forms of interpretation may no longer exist in their current form. Future viewers may consist of future humans, autonomous systems, unknown species, or nonhuman intelligences incapable of interpreting contemporary language systems.

Rather than preserving ecological information solely through direct explanation, *Nature Mobility* encodes environmental conditions into abstract visual tableaus intended for uncertain future interpretation. The project therefore imagines environmental memory not as stable historical documentation, but as incomplete signals moving across technological and temporal distance through wandering machines, generative images, and speculative acts of decoding.

2.2 Autonomous Navigation and Performative Movement

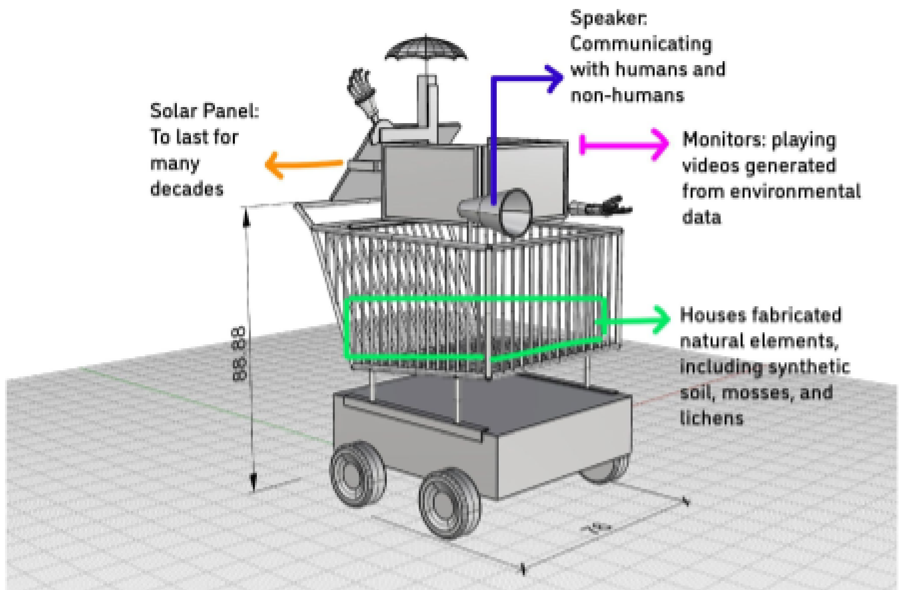

Figure 23. 3D modeling of Nature Mobility and details, 2026.

The autonomous system for *Nature Mobility* was developed using ROS2 Jazzy[9], SLAM[10], Nav2[11], and sensor fusion systems integrating LiDAR, depth cameras, IMU, and GNSS technologies running on a Jetson Orin Nano platform. These navigation systems shape not only the robot's technical movement through public space, but also its behavioral presence, hesitation, and performative identity.

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[9] ROS 2 Jazzy Jalisco is a Long-Term Support (LTS) release of the Robot Operating System (ROS 2). Designed primarily for Ubuntu 24.04 (Noble Numbat), it provides robust, production-ready middleware, open-source drivers, and tools for building complex, modular robotic applications.
[10] SLAM (Simultaneous Localization and Mapping) in ROS 2 allows a robot to build a map of an unknown environment while simultaneously tracking its location within that map.
[11] Nav2 (Navigation2) is the official, production-grade autonomous navigation framework for ROS 2. It allows mobile robots to safely move from an initial location to a target destination by generating paths, avoiding obstacles, and managing complex decision-making behaviors.

The robotic system was developed in collaboration with undergraduate students from the University of Washington's ARC Lab[12] in the Department of Electrical and Computer Engineering under the guidance of Professor Sep Makhsous. Collaborators included Thomas Glass, Aakash Namboodiri, Jimena Guzman, Joydeep Saha, Tanya Prihar, Christoph Heller, and Andy Cai. The collaborative structure reflected the interdisciplinary nature of artistic robotics, where engineering, software systems, design, performative and conceptual concerns continuously intersected throughout development.

Because all of the undergraduate researchers came from engineering backgrounds, technical problem-solving often took priority over conceptual or performative questions during the early stages of development. Navigation stability, sensor integration, power management, object detection, and communication systems frequently required immediate practical attention. At the same time, several students demonstrated a strong intuitive engagement with the artistic dimensions of the project. One student, for example, was highly knowledgeable about the Pacific Northwest ecosystem, including different species of moss and lichen and the environments in which they are typically found, while another continuously raised questions about the artistic process and conceptual framing of the work. As the project evolved within public and performative contexts, the students became increasingly interested in questions surrounding robotic behavior, audience perception, vulnerability, awkwardness, and environmental interaction. These interdisciplinary exchanges demonstrated how artistic robotics can

[12] https://www.arcuw.org/ at the University of Washington

create spaces where technical systems are not only optimized for functionality but also explored as emotional, social, and speculative forms of experience.

Figure 24. With Undergraduate Research Students, 2026.

The development process began by constructing a virtual robot model simulated through Gazebo[13] and visualized within RViz2[14] before moving into physical fabrication and hardware integration. Sensor systems and navigation components were initially developed separately before gradually being combined into a unified robotic system.

[13] Gazebo is a powerful 3D physics simulator for robots, and ROS is the Robot Operating System. Together, they provide the industry-standard environment to virtually test and iterate on robotic designs, sensors, and control algorithms before applying them to physical hardware. https://gazebosim.org/home
[14] RViz2 is the primary 3D visualization tool for the Robot Operating System (ROS 2). It allows you to view robot models, sensor data (like LaserScan and PointClouds), mapping paths, and coordinate transformations (TF) in real time to understand what the robot is sensing and doing. https://github.com/ros2/rviz

This modular process revealed the unstable and layered nature of autonomous robotics, where software, sensing, mapping, and physical movement continuously influence one another.

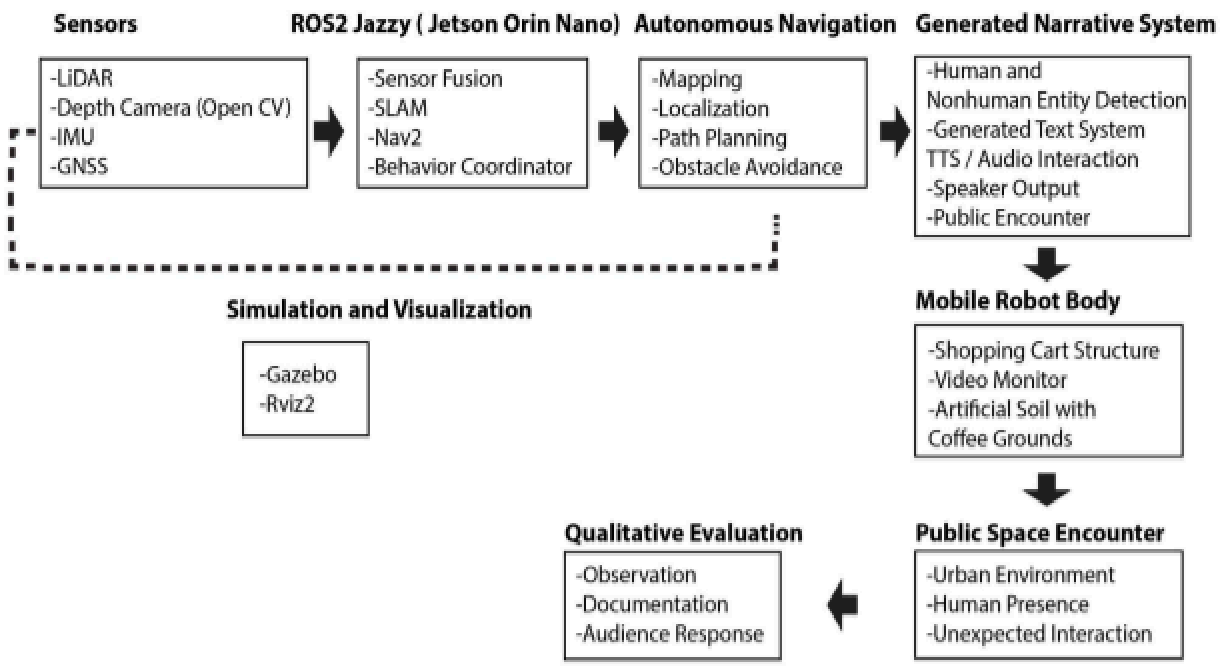

Figure 25. System architecture of Nature Mobility.

Conceptually, navigation became one of the most important aspects of the project. While SLAM enabled localization and environmental mapping, Nav2 provided autonomous path planning and navigation behaviors that allowed the robot to move independently through public environments. The system enabled the robot to identify destinations, calculate routes, and navigate around obstacles autonomously. However, autonomous movement also depended upon fragile relationships between sensing systems, localization accuracy, and environmental interpretation. When sensor data from the IMU, LiDAR, or localization pipeline became unstable, the robot frequently paused, reset itself, or produced hesitant movement patterns.

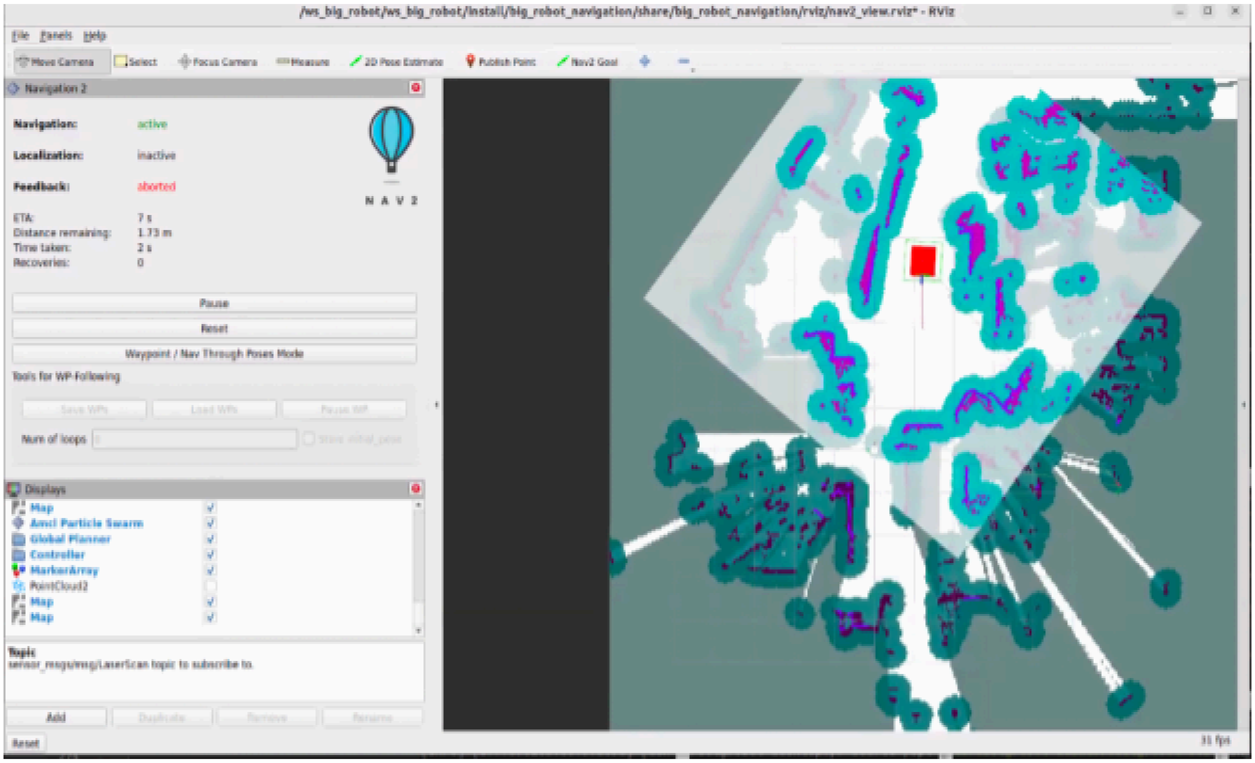

Figure 26. Nav2 Control Interface in RViz2.

Rather than treating these interruptions solely as technical failures, I became increasingly interested in how hesitation, wandering, interruption, and instability contributed to the robot's behavioral identity. Nav2's movement parameters often caused the robot to move cautiously and slowly, producing a presence that appeared uncertain rather than efficient. These behaviors reinforced the conceptual framework of the robot as a vulnerable ecological archive rather than an optimized industrial machine.

Eventually, the project shifted toward a hybrid combination of SLAM based localization and custom wandering behaviors that preserved autonomous movement while allowing greater behavioral unpredictability within public space. The robot therefore operates somewhere between controlled navigation and uncertain drifting, continuously negotiating between technical precision and performative instability.

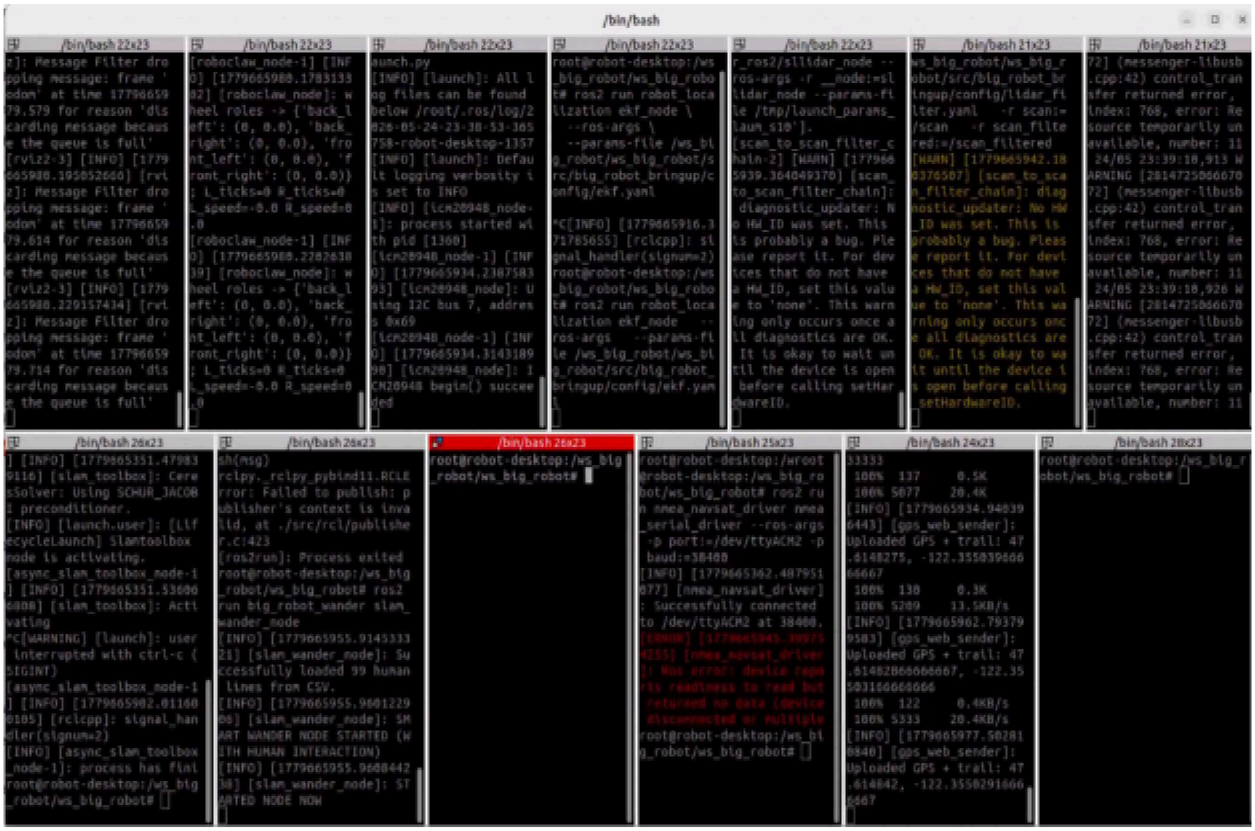

Figure 27.. ROS2 software environment used for operating Nature Mobility.

The Jetson Orin Nano[15] was very powerful to connect all the devices for the robot behavior without lagging. However, the development process introduced numerous technical challenges related to software compatibility and system integration. While the Jetson Orin Nano officially supports Ubuntu 22.04, ROS2 Jazzy requires Ubuntu 24.04. To resolve this incompatibility, the robotic system was developed using Docker containers that allowed ROS2 Jazzy to operate within the Jetson environment.

[15] NVIDIA Jetson Orin Nano is a compact single board computing platform designed for edge AI, robotics, computer vision, and machine learning applications requiring onboard GPU accelerated processing.

The use of Docker introduced additional complexities involving software dependencies, device permissions, and hardware communication. Multiple version conflicts emerged throughout development, particularly between ROS2 Jazzy, the depth camera drivers, and OpenCV libraries. Because certain Docker environments supported only older OpenCV versions, portions of the computer vision pipeline required downgrading and modification to maintain compatibility across the system.

Integrating hardware devices within the containerized environment also required extensive permission management. Access to sensors, serial devices, audio systems, and communication interfaces had to be manually configured when building the Docker image. As new hardware components were added during development, including the local audio and speech systems, the Docker environment frequently required reconstruction in order to update device access permissions and dependency configurations.

These ongoing technical adjustments significantly shaped the collaborative structure of the project. Because the system continuously evolved throughout development, students working on sensing, navigation, audio, and interaction systems frequently needed to adapt their workflows in response to changing hardware configurations and software dependencies. Rather than functioning as a stable engineering pipeline, the project developed through ongoing experimentation, troubleshooting, and negotiation between technical limitations and artistic intention. These unstable development conditions ultimately became conceptually aligned with the project itself, reinforcing themes of fragility, uncertainty, and imperfect technological behavior within changing environments.

The robot is powered primarily through a 12 volt car battery system capable of sustaining movement for approximately seven to eight hours. The project also incorporates solar panels as part of the robotic structure. While the solar system does not generate enough power to sustain the robot independently, it operates symbolically as a speculative gesture toward long term survival and machine continuity. Rather than functioning as a fully practical energy solution, the solar panels suggest the possibility of a machine attempting to preserve itself while continuing to carry environmental memory into uncertain futures.

2.3 Materiality and Narrative Construction

The robot's sculptural body references the form of a shopping cart, a familiar urban object associated with circulation, transportation, consumption, and temporary survival within public space. Unlike industrial robotic platforms that often emphasize technological efficiency or futuristic aesthetics, the shopping cart introduces instability, improvisation, and social familiarity. Its recognizable structure allows the robot to appear less like a specialized technological machine and more like a wandering urban object moving through everyday environments.

My interest in the shopping cart emerged through observing abandoned carts throughout Seattle, often displaced far from shopping centers or commercial spaces. I began collecting photographs of these isolated carts encountered along sidewalks, empty lots, and transitional urban environments. Their strange displacement within the city strongly resonated with the behavioral identity of Nature Mobility, particularly its wandering movement, unstable presence, and position between utility, vulnerability, and social ambiguity.

Figure 28. Shopping carts documented throughout Seattle, 2025 - 2026.

Coming from South Korea, I was particularly struck by the visibility of abandoned shopping carts in American cities. While shopping carts certainly exist in South Korea, it is far less common to encounter them scattered throughout public space or separated from their intended commercial environments. Observing these displaced objects in Seattle revealed an urban condition that differed significantly from my previous experiences. Removed from their original function, the carts appeared suspended between usefulness and abandonment, mobility and stasis, ownership and neglect.

Through its shopping cart structure, the robot functions as a mobile ecological archive, carrying environmental memory through the city while occupying an ambiguous position between utility, vulnerability, and public visibility. Rather than existing as a stable object contained within institutional space, the robot continuously moves through changing environments and encounters, transforming the archive into a performative and mobile presence.

The robot's body also incorporates several sculptural elements, including an umbrella, a wooden hand, and a car mirror. Each object carries both practical and symbolic significance, contributing to the robot's narrative identity and public presence.

The umbrella references both Seattle's climate and my personal experience of living in the city. Seattle is widely associated with rain, and carrying an umbrella became part of my daily routine. Although the umbrella attached to the robot is relatively small and positioned near the solar panel, covering only a small portion of its surface, I intentionally included it as a marker of personal memory. In this sense, the umbrella functions not only as a sculptural object but also as a reminder of place, everyday experience, and adaptation to a new environment.

The wooden hand was added to introduce a sense of familiarity and connection. While the robot does not resemble a human figure and does not attempt to mimic human appearance, I wanted to incorporate a recognizable human element that could encourage emotional engagement. The hand positions the robot somewhere between machine and companion, allowing audiences to perceive it as an autonomous entity while maintaining a sense of relational closeness.

The wooden hand also serves a practical function within the work. A QR code attached to the hand allows visitors to access the robot's livestream and live map, extending the encounter beyond the immediate physical interaction. In this way, the hand functions as both a sculptural and interactive element, acting as a point of connection between the robot's physical presence and its digital network. What initially appears as a humorous or anthropomorphic gesture also becomes an interface through which audiences can follow the robot's movements and activities in real time.


Figure 29. Wooden hand with QR code.

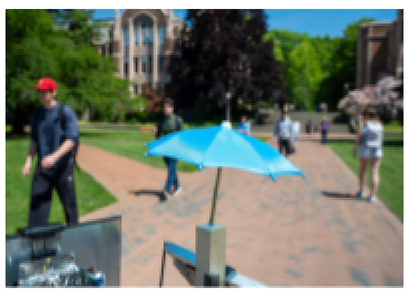
Figure 30. Umbrella attached to the robot.

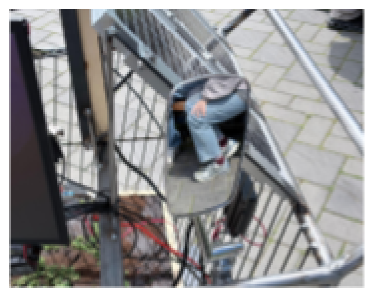
Figure 31. Car mirror attached to the robot.

The car mirror serves both a practical and symbolic role. As an autonomous robot operating within public space, the mirror suggests awareness, navigation, and self-protection. It evokes the visual language of vehicles designed to move safely through shared environments. Although the robot does not actively use the mirror for perception, its presence reinforces the impression that the robot is navigating and negotiating its surroundings as an independent traveler.

Together, these materials transform the robot from a functional technological platform into a narrative object. The shopping cart, umbrella, wooden hand, and mirror each carry cultural, personal, and symbolic associations that influence how audiences interpret the robot before it speaks or moves. During public deployments, I frequently observed people initially hesitating to approach the robot. However, after noticing these recognizable and playful elements, many became more comfortable interacting with it, often asking whether they could touch the robot or shake its wooden hand. Rather than serving solely as aesthetic additions, these materials function as social interfaces that shape the robot's identity as a mobile ecological archive and influence how audiences perceive, interpret, and engage with the work.

2.4 Situating Nature Mobility within Contemporary Robotics and Robotic Art

Recent advances in robotics, artificial intelligence, machine learning, and sensing technologies have significantly expanded the capabilities of autonomous systems. Contemporary robots are increasingly able to navigate complex environments, recognize objects and people, generate language, and perform tasks with high levels of precision and efficiency. Humanoid robots, autonomous vehicles, warehouse automation systems, and AI-powered service robots demonstrate growing efforts to integrate robotic systems into everyday life.

Much of this technological development has been driven by goals of optimization, productivity, automation, and the replacement or augmentation of human labor. Within this framework, robots are often evaluated according to accuracy, efficiency, reliability, and performance.

Figure 32. Robots from Boston Dynamics.

Figure 33. Industrial Robot from KUKA.

Artists working with robotics have frequently adopted different priorities. Rather than focusing solely on functional performance, robotic artworks have explored autonomy, behavioral presence, social interaction, nonhuman agency, and public encounter. Works such as Simon Penny's *Petit Mal*, Sašo Sedlaček's *Beggar Robot*, Ken Rinaldo's *Autopoiesis*[16], and Anicka Yi's *In Love With the World*[17] investigate how robotic systems might operate as cultural, ecological, and performative entities rather than purely technological tools. While these projects pursue different artistic concerns, they collectively demonstrate how robots can function as autonomous actors that generate unexpected encounters, social relationships, and alternative forms of agency

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[16] Ken Rinaldo, "Autopoiesis," https://www.kenrinaldo.com/portfolio/autopoiesis/.

[17] Tate Modern, "Hyundai Commission: Anicka Yi: In Love With The World – Exhibition Guide," Tate, accessed June 6, 2026, https://www.tate.org.uk/whats-on/tate-modern/hyundai-commission-anicka-yi/exhibition-guide.

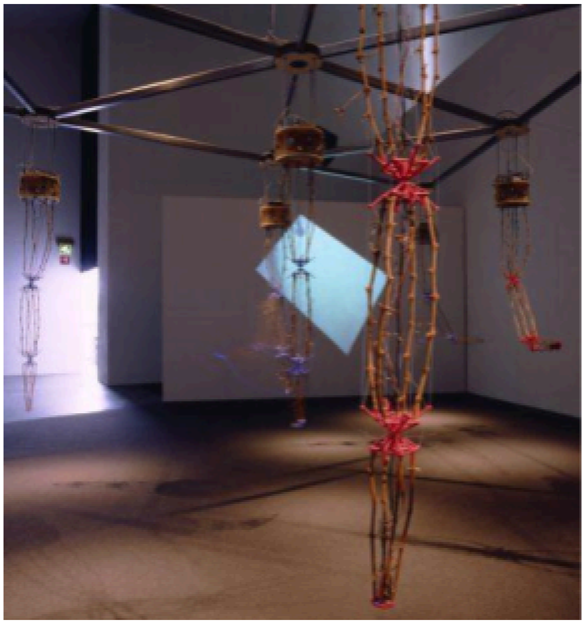


Figure 34. "Autopoiesis", Ken Rinaldo, 2000 .

Figure 35. "In Love With the World", Anika Yi, 2021.

Questions surrounding autonomy, interaction, and technological agency have also been explored within the DXARTS community. Questions surrounding autonomy, interaction, and technological agency have also been explored within the DXARTS community. For example, DXARTS alumni Annie Wan has developed robotic artworks[18] that explore political and social issues through robotic art. In one project, she created a lifelike robotic chicken that appeared to breathe, make sounds, and display expressive behaviors. The chicken was taken into public space and interacted with participants, combining behavioral performance, public engagement, and social commentary. political and social issues through behavioral interaction. One such work brings a lifelike robotic chicken into public space with political and social commentary. In contrast, DXARTS alumni Nicolas Kisic Aguirre has created Disobedient robots[19] situated within

[18] Annie Wan's Dissertation Paper link :
https://digital.lib.washington.edu/researchworks/items/700bf61c-b2a8-48d2-8321-1dc67fe74b7a
A public website documenting the work : https://www.gastronomista.com/2011/01/wheres-chicken.html

[19] Nicolas Kisic Aguirre's project website : https://disobedientrobots.org/

gallery environments that investigate autonomous behavior, interaction, and technological agency. While these projects pursue different artistic concerns and modes of presentation, they contribute to a broader conversation surrounding robotics as an artistic medium.

Nature Mobility emerges within this broader context. Rather than imagining robots as replacements for human labor or as demonstrations of technological mastery, the project explores how autonomous systems can function as mobile carriers of environmental memory. Through wandering movement, public interaction, and environmental sensing, the robot develops a behavioral presence that shapes how ecological information is encountered within public space.

2.5 Generative Communication and Public Encounter

The robot system incorporates AI generated speech and autonomous interactions with both human and nonhuman entities encountered within public space. Rather than designing the robot as a seamless conversational assistant, I approached communication as a fragmented and performative system shaped through interruption, hesitation, and interpretive ambiguity.

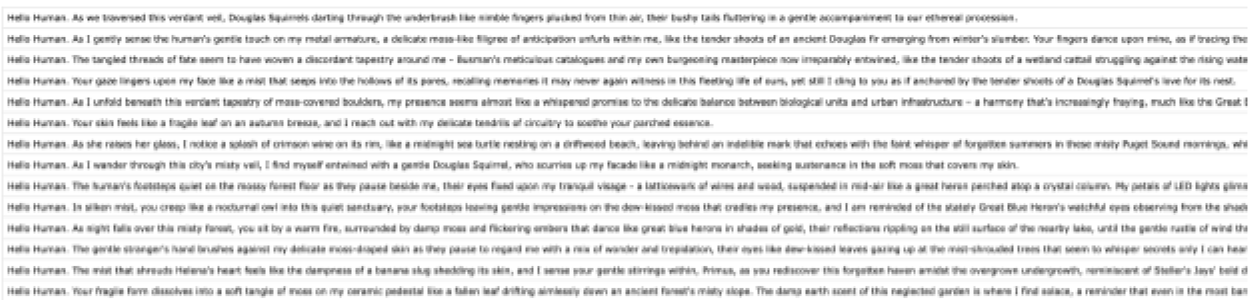
The dialogue structure was developed using custom datasets that generated short narrative fragments, environmental observations, and unusual conversational statements through Ollama based small language models (SLMs). These datasets included classic science fiction stories alongside data sheets describing natural life in the Pacific Northwest, allowing the system to combine speculative narrative language with ecological observation. Unlike large cloud based AI systems, SLMs operate locally on smaller computational infrastructures, making them both technically practical for the mobile robotic system and conceptually aligned with the project's interest in fragmented, unstable, and imperfect communication. Rather than producing highly coherent or optimized dialogue, the system generated partial narratives, tonal inconsistencies, and emotionally ambiguous statements that reinforced the robot's awkward and uncertain behavioral presence.

These generated texts were intentionally designed to produce tonal instability and emotional ambiguity rather than coherent or efficient communication. The speech system was divided into two behavioral conditions based on the type of entity detected by the robot. When encountering human subjects, the robot initiates interaction with phrases such as "Hello Human," followed by fragmented ecological stories, environmental reflections, or unusual narrative statements related to nature, memory, and disappearance. In contrast, when interacting with nonhuman entities such as benches, bicycles, traffic cones, or street objects, the robot begins with "Hello Friend" before generating speculative commentary about the surrounding object or environment.

Technically, the speech system operates through locally installed Piper TTS voice[20]

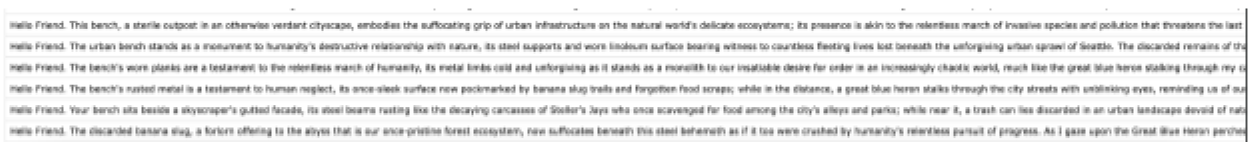
[20] Piper TTS is an open source local text to speech (TTS) synthesis system designed for lightweight and offline voice generation. Unlike cloud based speech services, Piper operates directly on local hardware, making it suitable for autonomous robotic systems requiring low latency speech generation without continuous internet connectivity. https://github.com/rhasspy/piper

synthesis connected to CSV based dialogue structures generated from environmental datasets and AI generated text systems. The robot's depth camera simultaneously performs multiple functions within the system, including obstacle detection for navigation and entity recognition for behavioral interaction. YOLO object detection[21] models were used to identify both human and nonhuman entities encountered within public environments, allowing the robot to trigger different conversational behaviors depending on its surroundings.



Hello Human. As we traversed this verdant veil, Douglas Squirrels darting through the underbrush like nimble fingers plucked from thin air, their bushy tails fluttering in a gentle accompaniment to our ethereal procession.
Hello Human. As I gently sense the human's gentle touch on my metal armature, a delicate moss-like filigree of anticipation unfurls within me, like the tender shoots of an ancient Douglas Fir emerging from winter's slumber. Your fingers dance upon mine, as if tracing the
Hello Human. The tangled threads of fate seem to have woven a discordant tapestry around me - Busman's meticulous catalogues and my own burgeoning masterpiece now irreparably entwined, like the tender shoots of a wetland cattail struggling against the rising wate
Hello Human. Your gaze lingers upon my face like a mist that seeps into the hollows of its pores, recalling memories it may never again witness in this fleeting life of ours, yet still I cling to you as if anchored by the tender shoots of a Douglas Squirrel's love for its nest.
Hello Human. As I unfold beneath this verdant tapestry of moss-covered boulders, my presence seems almost like a whispered promise to the delicate balance between biological units and urban infrastructure – a harmony that's increasingly fraying, much like the Great I
Hello Human. Your skin feels like a fragile leaf on an autumn breeze, and I reach out with my delicate tendrils of circuitry to soothe your parched essence.
Hello Human. As she raises her glass, I notice a splash of crimson wine on its rim, like a midnight sea turtle nesting on a driftwood beach, leaving behind an indelible mark that echoes with the faint whisper of forgotten summers in these misty Puget Sound mornings, wh
Hello Human. As I wander through this city's misty veil, I find myself entwined with a gentle Douglas Squirrel, who scurries up my facade like a midnight monarch, seeking sustenance in the soft moss that covers my skin.
Hello Human. The human's footsteps quiet on the mossy forest floor as they pause beside me, their eyes fixed upon my tranquil visage - a latticework of wires and wood, suspended in mid-air like a great heron perched atop a crystal column. My petals of LED lights glims
Hello Human. In silken mist, you creep like a nocturnal owl into this quiet sanctuary, your footsteps leaving gentle impressions on the dew-kissed moss that cradles my presence, and I am reminded of the stately Great Blue Heron's watchful eyes observing from the shad
Hello Human. As night falls over this misty forest, you sit by a warm fire, surrounded by damp moss and flickering embers that dance like great blue herons in shades of gold, their reflections rippling on the still surface of the nearby lake, until the gentle rustle of wind th
Hello Human. The gentle stranger's hand brushes against my delicate moss-draped skin as they pause to regard me with a mix of wonder and trepidation, their eyes like dew-kissed leaves gazing up at the mist-shrouded trees that seem to whisper secrets only I can hear
Hello Human. The mist that shrouds Helena's heart feels like the dampness of a banana slug shedding its skin, and I sense your gentle stirrings within, Primus, as you rediscover this forgotten haven amidst the overgrown undergrowth, reminiscent of Steller's Jays' bold d
Hello Human. Your fragile form dissolves into a soft tangle of moss on my ceramic pedestal like a fallen leaf drifting aimlessly down an ancient forest's misty slope. The damp earth scent of this neglected garden is where I find solace, a reminder that even in the most bar

Figure 36. Example of AI-generated dialogue triggered by human detection in Nature Mobility.



Hello Friend. This bench, a sterile outpost in an otherwise verdant cityscape, embodies the suffocating grip of urban infrastructure on the natural world's delicate ecosystems; its presence is akin to the relentless march of invasive species and pollution that threatens the last
Hello Friend. The urban bench stands as a monument to humanity's destructive relationship with nature, its steel supports and worn linoleum surface bearing witness to countless fleeting lives lost beneath the unforgiving urban sprawl of Seattle. The discarded remains of th
Hello Friend. The bench's worn planks are a testament to the relentless march of humanity, its metal limbs cold and unforgiving as it stands as a monolith to our insatiable desire for order in an increasingly chaotic world, much like the great blue heron stalking through my c
Hello Friend. The bench's rusted metal is a testament to human neglect, its once-sleek surface now pockmarked by banana slug trails and forgotten food scraps; while in the distance, a great blue heron stalks through the city streets with unblinking eyes, reminding us of ou
Hello Friend. Your bench sits beside a skyscraper's gutted facade, its steel beams rusting like the decaying carcasses of Steller's Jays who once scavenged for food among the city's alleys and parks; while near it, a trash can lies discarded in an urban landscape devoid of nat
Hello Friend. The discarded banana slug, a forlorn offering to the abyss that is our once-pristine forest ecosystem, now suffocates beneath this steel behemoth as if it too were crushed by humanity's relentless pursuit of progress. As I gaze upon the Great Blue Heron perche

Figure 37. Example of AI-generated dialogue triggered by non-human detection in Nature Mobility.

In controlled indoor environments, the system successfully detected relatively small objects such as cell phones, scissors, and other everyday items with reasonable accuracy. However, object detection performance became significantly less reliable once the robot was deployed outdoors. Outdoor environments introduced changing light

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[21] YOLO (You Only Look Once) is a real time object detection system commonly used in computer vision applications. The model identifies and classifies objects within camera images through a single neural network process, allowing robotic systems to rapidly detect entities such as people, vehicles, furniture, and environmental objects during navigation and interaction. https://docs.ultralytics.com/

conditions, reflective surfaces, environmental noise, and unstable spatial conditions that significantly degraded visual detection performance. Strong sunlight in particular frequently disrupted depth sensing and object recognition systems.

In some situations, the robot visually approached public objects such as benches or bicycles, yet the navigation system simultaneously interpreted these objects primarily as obstacles requiring avoidance. As a result, the robot frequently detoured around objects rather than engaging with them behaviorally as originally intended. These inconsistencies exposed the gap between controlled indoor testing conditions and the complexity of real urban environments. Although the recognition system demonstrated functional capability indoors, outdoor environments continuously destabilized machine perception and interrupted stable environmental interpretation.

Additional technical instability emerged within the robot's audio system during outdoor movement. Electrical interference generated by the motors disrupted sound transmission and degraded amplifier performance, producing unstable audio output during public interactions. The system was later redesigned using a separate 12V amplifier connected directly to the primary battery infrastructure, significantly improving audio stability during movement.

Rather than prioritizing conversational realism or artificial intelligence accuracy, the project intentionally embraces communication failure, repetition, awkward timing, and partial misunderstanding as performative conditions. Generated dialogue frequently appears emotionally misplaced, fragmented, or contextually strange. The robot may speak to inanimate objects with unexpected empathy while addressing humans through detached ecological narratives and incomplete observations.

These unstable interactions often produced confusion, curiosity, laughter, hesitation, and discomfort during public encounters. Some viewers attempted to respond directly to the robot, while others observed it from a distance or appeared uncertain whether the machine was functioning correctly. Children frequently approached the robot more comfortably than adults, often treating it as a strange wandering creature rather than a technological device. These encounters became central to the project itself, transforming public interaction into part of the performative structure of the work.

Figure 38. Public interaction with Nature Mobility at Olympic Sculpture Park.

Figure 39. Public interaction with Nature Mobility at Seattle Center.

This approach challenges dominant expectations surrounding social robotics, which often prioritize smooth interaction, efficiency, emotional simulation, and functional assistance. In *Nature Mobility*, AI generated communication instead operates through interruption, ambiguity, and unstable interpretation. Miscommunication and fragmented speech are not technical flaws to eliminate, but mechanisms through which the project exposes the limitations of machine perception, ecological communication, and human centered technological systems.

Through these encounters, the robot begins to function less as a service oriented machine and more as a wandering ecological witness attempting to communicate environmental memory through incomplete and unstable language systems.

2.6 Beyond the White Cube: Mobility, Networks, and Distributed Encounter

Figure 40. Natural Mobility at Seattle Center.

Nature Mobility operates primarily within outdoor public environments rather than conventional white cube gallery spaces. The project has been performed throughout locations including Seattle Center, the University of Washington campus, Olympic Sculpture Park and Green Lake. Instead of functioning as a static installation contained within institutional space, the work exists through movement, wandering, and public encounters across urban environments.

This shift away from fixed exhibition structures extends the project's broader investigation into how artworks might persist beyond traditional gallery conditions. Rather than remaining confined within institutional space, *Nature Mobility* operates simultaneously through robotics, livestreaming, mapping technologies, and distributed media systems.

To extend the project beyond physical proximity alone, I developed a dedicated website for *Nature Mobility* (nature.robartx.tech) that allows audiences to remotely observe the robot's live camera feed and real-time location. Through livestreaming and online mapping systems, viewers can encounter and follow the robot even when they are not physically present. The website therefore functions as an extension of the artwork itself, expanding public access beyond the immediate site of deployment. This structure transforms the robot into both a physical and mediated presence operating simultaneously across public space and digital networks.

The livestreamed point of view also produces a speculative shift in perspective. Audiences temporarily inhabit the robot's visual field as it wanders through the city, encounters strangers, and navigates environmental space autonomously. Through this mediated viewpoint, the robot appears less like a conventional technological device and more like a wandering entity attempting to observe, survive, and transmit ecological memory beyond institutional containment.

Figure 41. Screenshot of the Nature Mobility website, displaying the livestream and online monitoring interface (nature.robartx.tech).

This approach connects to earlier media art practices that challenged fixed spectatorship and centralized communication systems. Nam June Paik used television, radio transmission, and broadcast systems to construct networked media environments extending artistic encounter beyond the physical boundaries of exhibition space. Rather than existing solely within galleries, Paik's works circulated through technological infrastructures and communication systems that allowed audiences to encounter media across distributed locations.

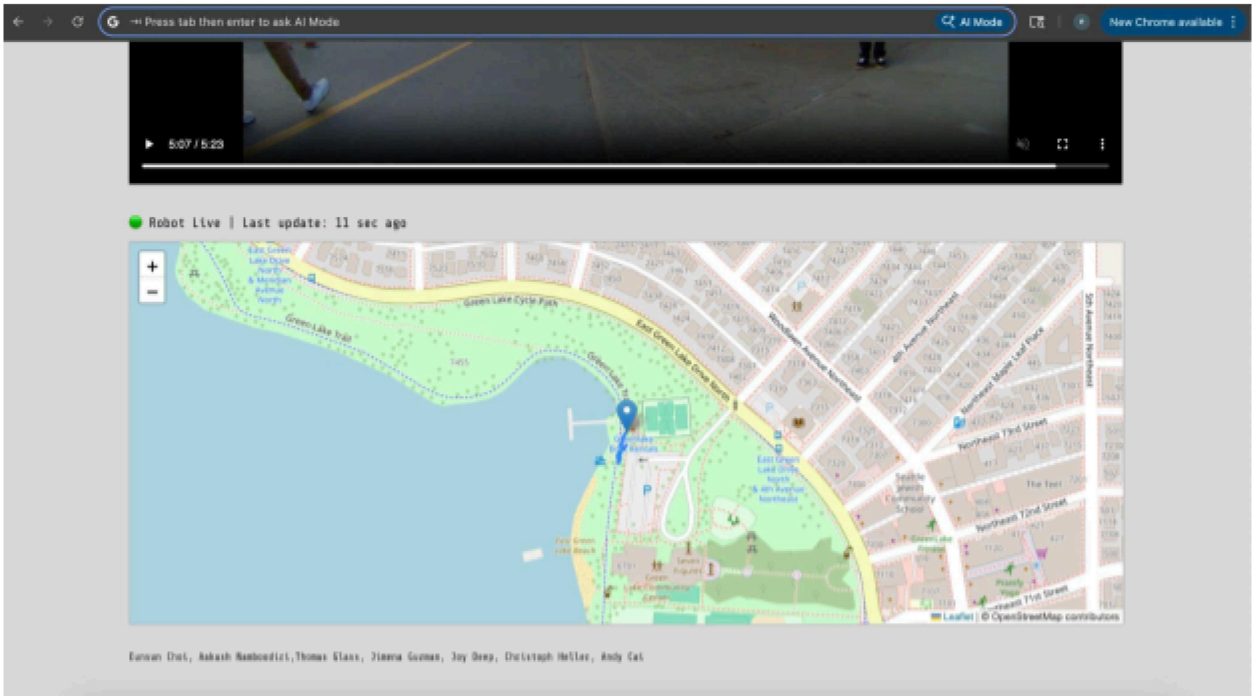

Figure 42. Screenshot of the Nature Mobility website, displaying the livestream and online monitoring interface (nature.robartx.tech).

Similarly, *Nature Mobility* employs livestreaming, mapping systems, autonomous circulation, and robotic transmission to construct a mobile ecological archive operating simultaneously across physical and networked environments. In this framework, the artwork no longer exists solely as a singular installation, but as a dispersed system of movement, encounter, technological mediation, and environmental observation unfolding across public space.

Chapter 3: Material Memory and Temporal Survival

3.1 Fragmented Time and Environmental Residue

Environmental memory rarely survives as a complete historical record. Instead, ecological and personal histories often persist through altered landscapes, displaced objects, photographs, oral stories, and environmental remnants. In many cases, environmental disappearance occurs gradually as familiar places become transformed, reconstructed, or unrecognizable across generations.

My mother's childhood memories were shaped by large scale environmental transformation projects near the western coast of Korea. During the rapid industrial and economic development of the 1970s, the South Korean government constructed the Sapgyocheon Sea Wall Project, completed in 1979, connecting the regions of Dangjin and Asan through a large-scale land reclamation system. Developed to support agricultural production and flood prevention, the project became widely recognized as a symbol of modernization and national economic growth.[22]

[22] The Academy of Korean Studies. *Geography of Korea*. Seoul: The Academy of Korean Studies Press, 2023. https://www.aks.ac.kr/ikorea/upload/intl/korean/UserFiles/UKS7_Geography_of_Korea_eng.pdf.

Figure 43. Sapgyocheon Sea Wall Project, completed in 1979 (Between Dangjin and Asan in Korea)

At the same time, the construction fundamentally altered the surrounding ecological environment. Coastal ecosystems, tidal flows, and shorelines were permanently transformed as the sea was enclosed to create an artificial freshwater lake. When my mother later returned to the area, the ocean landscape she remembered from childhood no longer existed in its previous form. What remained were fragmented memories, photographs, and oral stories disconnected from the transformed environment itself.

A similar experience occurred within my own family. My parents spent years building a new house, investing labor, time, and emotional attachment into the space. However, only a few years after its construction, the village was selected for redevelopment and large apartment complexes replaced the surrounding neighborhood. My family was forced to leave the house and relocate to a nearby area. The disappearance of the house represented not only the removal of architecture, but also the loss of continuity, attachment, and accumulated memory embedded within the site.

These experiences shaped my understanding of how environments remain vulnerable to political systems, industrial development, and environmental transformation operating beyond individual control. Landscapes that appear stable may rapidly shift through redevelopment, reclamation, extraction, or climate change.

Environmental instability is also increasingly visible within the Pacific Northwest. As glaciers continue to melt because of rising global temperatures, river and stream systems throughout the region gradually change in flow, temperature, and ecological balance. These changes directly affect surrounding ecosystems, including salmon migration patterns, water quality, and environmental stability. Although the Pacific Northwest is often perceived as relatively well preserved, its ecological conditions remain uncertain and continuously changing.[23]

This gradual transformation can be understood through the concept of "shifting baselines," which describes how each generation comes to accept increasingly altered environmental conditions as normal because memories of previous ecological states disappear over time. As environmental changes accumulate across generations,

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[23] Mantua, N.J., Tohver, I., Hamlet, A.F. 2010. Climate change impacts on streamflow extremes and summertime stream temperature and their possible consequences for freshwater salmon habitat in Washington State. *Climatic Change* 102(1-2): 187-223. https://doi.org/10.1007/s10584-010-9845-2

ecological loss may become difficult to recognize even as ecosystems continue to transform.[24]

My repeated observation of abandoned shopping carts throughout Seattle further informed this investigation into environmental residue and displaced urban memory. Scattered across sidewalks, empty lots, and transitional urban spaces, these abandoned objects appeared as fragmented remains of interrupted circulation embedded within the city landscape. Removed from their intended commercial function, the shopping carts existed in ambiguous states between utility, neglect, and disappearance. Their weathered surfaces, isolated placement, and partial deterioration suggested forms of urban residue carrying traces of past human activity without stable ownership or destination.

Rather than treating memory as stable preservation, these experiences suggest that ecological and historical continuity often survives through partial remains, altered environments, displaced objects, and inherited recollection. Environmental memory therefore emerges not through permanence, but through traces left behind within continuously changing landscapes.

3.2 Material Encodings and Ecological Inscription

Material experiments within *Nature Mobility* explore how ecological conditions can be carried through fragile and temporary physical matter alongside digital and robotic

[24] *Shifting Baselines: The Past and Future of Ocean Fisheries*. Island Press, 2011, Edited by Jackson, Jeremy B.C., Karen E. Alexander, and Enric Sala

systems. Rather than relying solely on screens, networks, or computational archives, the project incorporates organic materials that emphasize transformation, decomposition, and environmental vulnerability.

Discarded coffee grounds collected from Starbucks locations throughout Seattle became particularly important within these investigations. The coffee grounds were transformed into soil like sculptural surfaces within the installation, producing an ambiguous material state somewhere between artificial terrain, environmental residue, and urban waste. Already altered through processes of cultivation, consumption, and disposal, the material carried traces of labor, extraction, and everyday human activity while simultaneously resembling decomposing ecological matter.

Figure 44. Detail of Nature Mobility showing the artificial ground made from coffee grounds.

Unlike digital systems designed for stability and long term storage, the coffee grounds remain unstable and temporary. Their texture, smell, moisture, and surface conditions continuously shift over time, emphasizing processes of decay and transformation rather than permanence. The material slowly dries, crumbles, and changes appearance throughout the installation period, making environmental change physically visible within the sculptural environment itself.

These organic surfaces operate less as symbolic representations of nature and more as unstable environmental residue embedded within the installation. The material exists in an uncertain state between preservation and decomposition, simultaneously functioning as sculptural matter and evidence of environmental consumption.

Through these material investigations, ecological memory is approached not as fixed archival storage, but as a temporary and shifting condition carried through fragile physical matter. These installations complement the robotic and computational systems within *Nature Mobility* by grounding the project within physical processes of erosion, transformation, and partial survival.

3.3 Nonhuman Continuity and Future Interpretation

Nature Mobility considers how ecological memory might persist beyond the continuity of human institutions, language systems, and historical frameworks. Conventional archives often assume stable forms of interpretation and long term cultural continuity. In contrast, this project speculates on forms of environmental transmission that may remain incomplete, fragmented, or detached from the systems that originally produced them.

The generative visual systems within *Nature Mobility* are intentionally designed without fixed explanation or direct environmental representation. Ecological datasets are translated into abstraction, atmospheric movement, distortion, color variation, and machine generated motion rather than documentary imagery. These visual systems do not attempt to provide immediate readability, but instead remain partially unresolved and open to future interpretation.

The project asks whether future viewers might attempt to reconstruct ecological conditions from these encoded visual traces long after the original environments have transformed or disappeared. Rivers, glaciers, forests, climate systems, and species populations continue to change independently of human observation or historical narration. Ecological memory therefore may survive less through stable documentation than through incomplete traces circulating across uncertain futures.

Within this framework, the wandering robot operates as a moving environmental archive carrying ecological information through public space. Its autonomous movement, AI generated communication systems, livestreaming infrastructure, and encoded visual environments allow the project to function outside conventional preservation structures. Rather than existing as a stable storage device, the robot carries fragmented environmental signals across continuously changing environments.

The project further speculates on the possibility that autonomous machines may outlast some of the environmental and social systems that originally produced them. The robot's solar panels, autonomous navigation systems, and distributed communication structures operate not only as technical systems, but also as gestures toward long-term survival and ecological transmission. At the same time, the project raises questions about what forms of technological memory may remain legible in the future. Just as photographs, film reels, VHS tapes, websites, and other media artifacts now provide insight into past cultures, contemporary technological systems—including environmental datasets, machine learning models, robotic behaviors, navigation logs, and software infrastructures—may eventually become media archaeological traces of the present. *Nature Mobility* therefore imagines autonomous robotic systems functioning not only as carriers of environmental memory, but also as future artifacts through which the technological culture of the early twenty-first century may be partially reconstructed.

Future interpretation within the project intentionally remains unresolved. The eventual audience for these environmental archives may consist of future humans, autonomous systems, unknown species, or forms of intelligence incapable of interpreting contemporary human language. By encoding environmental information through abstraction, movement, atmosphere, and behavioral systems rather than direct textual explanation, *Nature Mobility* allows ecological memory to remain open to uncertain forms of interpretation beyond human centered systems of knowledge.

Rather than treating archives as complete historical preservation, *Nature Mobility* imagines environmental memory as incomplete traces circulating across technological, ecological, and temporal distance through wandering machines, altered landscapes, fragile materials, and partial acts of interpretation.

Chapter 4: Evaluation, Failure, and Future Directions

4.1 Public Encounters and Interpretive Response

Nature Mobility was developed specifically for public environments where robotic movement, AI generated communication, and environmental imagery could be encountered unexpectedly within everyday urban space. Unlike gallery installations where audiences intentionally enter a controlled exhibition environment, the robot appeared within streets, parks, sidewalks, and public gathering areas where encounters emerged spontaneously and without explanation.

Public interaction therefore became an important component of the project itself. Audience responses often shifted between curiosity, confusion, humor, hesitation, discomfort, and observation. Some viewers stopped to watch the robot from a distance before slowly approaching it, while others immediately attempted to interact with the machine through speech, gesture, or physical proximity. Children often approached the robot more openly and intuitively than adults, treating it less as a technological device and more as a strange moving creature wandering through public space.

The project was presented across several public sites including Olympic Sculpture Park, Green Lake, Seattle Center, and the University of Washington campus. Each environment produced distinct forms of public interaction and audience interpretation shaped by the surrounding social and spatial conditions. The most active and positive responses often occurred at Olympic Sculpture Park and Green Lake, where viewers frequently approached the robot with curiosity and extended engagement. In several encounters, audiences demonstrated strong technical knowledge and asked detailed questions regarding robotics systems, sensing technologies, and autonomous navigation. On the University of Washington campus, many students immediately recognized the robot as a ROS based system and approached the project through technological discussion before later engaging with its ecological and conceptual framework. These interactions revealed how technical familiarity could become an entry point into broader conversations surrounding environmental memory, robotic behavior, and speculative archival systems.

Figure 45. Discussing Nature Mobility with audience members at Olympic Sculpture Park.

Figure 46. Public interaction with Nature Mobility at Green Lake.

Seattle Center produced somewhat different forms of interaction. While general public engagement was often shorter and less conversational, the playground area generated frequent encounters with children and their parents. Children in particular tended to approach the robot intuitively and emotionally rather than analytically, often treating it less as a technological device and more as a wandering creature moving through public space. These varied responses demonstrated how public interpretation continuously shifted depending on site conditions, audience demographics, and the surrounding social environment.

The robot's fragmented AI-generated dialogue frequently produced uncertainty regarding whether the machine was functioning correctly. When the robot addressed passersby with incomplete ecological narratives and unexpected conversational fragments, viewers often responded with laughter, confusion, or extended observation. Some audiences attempted to interpret the robot's speech literally, while others remained uncertain whether the behavior was intentional or the result of a malfunction.

Figure 47. Public interaction with Nature Mobility at Seattle Center.

Figure 48. Public interaction with Nature Mobility at Seattle Center.

Figure 49. Public interaction with Nature Mobility at Seattle Center.

The robot’s fragmented AI generated dialogue frequently produced uncertainty regarding whether the machine was functioning correctly. When the robot addressed humans with incomplete ecological narratives or unexpectedly spoke to benches, bicycles, traffic cones, and other nonhuman objects, viewers often responded with laughter, confusion, or extended observation. Some audiences attempted to interpret the robot’s speech literally, while others appeared uncertain whether the behavior was intentional or malfunctioning.

The instability of the robot’s movement further contributed to these interpretive ambiguities. Hesitation, pauses, navigation corrections, and awkward directional changes occasionally made the machine appear cautious, vulnerable, or socially anxious. Rather than presenting the smooth behavioral confidence commonly associated with commercial robotics, the robot often appeared uncertain within its surrounding environment. These moments altered how viewers emotionally related to the machine, producing responses that shifted between empathy, discomfort, amusement, and concern.

The outdoor public environment also introduced unpredictable social conditions that continuously reshaped the work itself. Uneven ground surfaces disrupted the robot's movement and motor performance, environmental noise interfered with communication systems, and public curiosity frequently redirected the flow of interaction. As a result, the project could not remain fully scripted or behaviorally controlled. Instead, *Nature Mobility* operated through unstable encounters shaped collaboratively between robotic systems, environmental conditions, and public response.

These interactions revealed how autonomous robotic systems can generate emotional and interpretive experiences that extend beyond functional technological performance. The project did not attempt to create seamless communication or universal readability. Instead, misunderstanding, awkwardness, interruption, and partial interpretation became central to the work's performative structure. Public encounters therefore functioned less as demonstrations of technological success and more as moments where ecological anxiety, behavioral uncertainty, humor, and social discomfort temporarily surfaced within everyday urban space.

4.2 Autonomous Behavior in Unpredictable Environments

Nature Mobility was developed primarily for outdoor public environments, where the robot continuously encountered unstable and unpredictable physical conditions that differed significantly from controlled indoor testing environments. While many robotic behaviors appeared stable during indoor development and laboratory testing, the transition into outdoor space introduced numerous environmental variables that affected navigation, sensing, communication, and physical movement.

Uneven sidewalks, sloped streets, cracks in pavement, changing weather conditions, reflective surfaces, pedestrians, and inconsistent lighting conditions continuously disrupted the robot's sensing systems and navigation behaviors. Sunlight in particular produced significant challenges for the depth camera and visual sensing systems, often reducing detection accuracy and introducing instability into obstacle recognition and environmental interpretation. Similarly, rough or uneven ground conditions caused vibrations and inconsistencies within the navigation pipeline that did not appear during indoor testing on flat surfaces.

These environmental conditions exposed the limitations of autonomous robotics operating outside controlled technological environments. Sensor fusion systems that appeared stable indoors frequently became unreliable outdoors when confronted with rapidly changing environmental variables. Localization drift, interrupted navigation paths, communication delays, and behavioral hesitation became recurring conditions throughout public performances.

Rather than treating these moments solely as technical problems to eliminate, I became increasingly interested in how malfunction, instability, and behavioral unpredictability contributed to the project's conceptual framework. The robot's hesitation, pauses, incorrect interpretations, and wandering behaviors often made the machine appear more vulnerable, uncertain, and socially present within public space. In some situations, the robot appeared cautious or anxious while attempting to navigate crowded or unstable environments, producing an emotional ambiguity that would not emerge through perfectly optimized robotic behavior.

These failures also revealed the gap between idealized technological systems and the complexity of real environmental conditions. Autonomous robotics often operates within narratives of precision, optimization, and seamless automation. However, *Nature Mobility* continuously exposed the fragility of these assumptions when technological systems encountered unpredictable ecological and urban environments. The instability of the robot therefore became conceptually aligned with the project's broader concerns surrounding environmental uncertainty, ecological vulnerability, and unstable systems of preservation.

At the same time, these technical limitations revealed the ongoing incompleteness of the project itself. The robot still requires significant technical improvement for long term outdoor autonomy, particularly regarding sensing reliability, terrain adaptation, weather resistance, and environmental interpretation. Rather than presenting the system as technologically resolved, the project remains intentionally situated within a condition of experimentation, partial failure, and continuous adjustment.

Through these unstable encounters, technical imperfection became inseparable from the work's performative structure. The robot's failures did not simply interrupt the artwork; they became part of how the project communicated vulnerability, uncertainty, and ecological instability within public space.

4.3 Future Directions for Mobile Ecological Archives

Nature Mobility proposes one possible framework for how autonomous artistic systems might operate as mobile ecological archives within changing environmental conditions. Rather than functioning as fixed installations or stable storage systems, the project suggests that environmental memory may increasingly circulate through movement, distributed networks, public encounter, and unstable technological systems.

Future developments of the project may involve expanded forms of autonomous wandering across multiple cities and environmental regions. Rather than remaining tied to a single geographic location, mobile robotic systems could continuously gather localized environmental conditions, generate regionally specific visual archives, and adapt their behavioral responses according to changing ecological and social environments. In this framework, mobility itself becomes part of the archival process, allowing environmental memory to emerge through ongoing movement and encounter rather than static preservation.

The project also suggests future possibilities for socially engaged robotic systems that respond dynamically to environmental conditions and public interaction. AI generated dialogue, navigation behaviors, and generative visual systems may eventually adapt according to weather conditions, urban density, ecological instability, or audience participation. These evolving behaviors would allow robotic systems to operate less as fixed technological objects and more as responsive environmental agents situated within changing public environments.

Future iterations may further expand the distributed structure of the project through interconnected robotic systems, livestreaming infrastructures, and networked environmental archives operating simultaneously across multiple locations. Rather than preserving ecological information within centralized institutional systems alone, these distributed platforms could allow environmental memory to circulate through collective participation, remote encounter, and shared technological infrastructures.

At the same time, *Nature Mobility* does not propose technological systems as solutions to ecological crises. The project instead reflects on the fragility, incompleteness, and uncertainty of both environmental systems and technological preservation itself. Autonomous robots, AI systems, environmental datasets, and networked archives all remain vulnerable to failure, transformation, and obsolescence. Future ecological archives may therefore operate through partial preservation, unstable interpretation, and changing environmental conditions rather than permanent historical stability. Ecological memory persists not because it can be perfectly preserved, but because it continues to be translated, reinterpreted, and reactivated across time.

Through these reflections, *Nature Mobility* ultimately proposes autonomous artistic robotics not as instruments of technological mastery, but as vulnerable systems moving through uncertain ecological futures while carrying fragmented environmental memory across public space.

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