When the observer becomes the observed

A critical alternative to environment sensing through embodied engagement with a generative system

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Figure 1: Conceptual art illustrating an observer becoming the observed. The image depicts a dancer being captured by an AI system that recognizes his movements and generates descriptive words based on the motion of each body part and the surrounding environment.

Abstract

Traditional sensors function as exact measuring instruments to represent the physical world. Conversely, humans are subjective, inaccurate sensors, whose measured quantities are often influenced by their perception of the environment. In this project, we speculate on the possibility of a sensing system where the human being becomes the sensor. We observe the human sensor through their movement, as a performative expression of the measure. We explore this concept through site-specific embodied practices, gathering

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movement and textual expressions related to environmental sensing from professional choreographers. This data is then utilized to fine-tune a large language model that generates abstract words based on the input movements. This language model is integrated into a system as a critical alternative to the technology of sensing, where the process of sensing turns into reflecting the observer's subjective body expression rather than providing a 1:1 mapping of the phenomenon.

CCS Concepts

• **Human-centered computing** → **HCI theory, concepts and models**; • **Applied computing** → *Media arts*; • **Computing methodologies** → Artificial intelligence.

Keywords

Sensor, Movement Performance, Critical Theory, Generative AI System

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1 Introduction

Sensors pervade every aspect of modern society, embedded in all sorts of "intelligent" machines from simple home appliances to complex, large-scale measurement and prediction systems. As such, the data measured ranges from low-stakes, hyper-local, such as room temperature and humidity, all the way to phenomena at the limit of human knowledge, such as galaxies located billions of light-years away. However, questions remain regarding how effectively the numerical information provided by sensors encapsulates physical reality. This limitation prompts our investigation into "representationalism", which theorizes that we experience the world through its representations rather than directly interacting with physical reality. In line with such views, theoretical physicist Karen Barad proposes that information gathering should be "performative." She argues that the apparatus used for observation and the observed object together shape our knowledge [Barad 2007]. In the context of environmental sensors, the practices set by their developers often cause people to overlook the agency of observation in knowledge acquisition, reinforcing the belief in an absolute truth that is unified in quantifiable data.

In contrast, the human perception of the environment is rooted in personal relationships with the surroundings and subjective interpretations of stimuli. Similar to traditional sensors that represent the measured quantity as an analog or digital signal, movement can act as a direct representation of the human's individual perception of the environment. However, compared to traditional sensors that tend to provide limited variations around their measured value, human movement may vary greatly. For instance, a room temperature of 17°C may be comfortable for one individual, but cause another to wrap their arms around themselves as a direct yet often unconscious reaction to their personal understanding of the environment. We approach this by considering human movement as a form of sensing expression. Our project examines and critiques the traditional belief in settled agency in the sensors' measuring process, where one can obtain singular, absolute facts from the environment by using the right tool. We raise the question *What if the observer becomes the observed?*.

Inspired by a workshop on measuring the environment using body movements and sensory map [McLean 2019], we designed a generative system as a critical alternative to environment sensing, reflecting the subjective human embodied expression. The system takes Large Language Models(LLMs) as the main medium, as a rebuttal to the deterministic function in processing data. To have a language model tailored to the entanglement between movement and environment sensing, we held a dataset co-design workshop with professional choreographers. This dataset was used to train the LLM, resulting in a system that takes unlabeled human movement as input and generates emergent words as output. This method introduces movement makers into the observer-observed loop, a reference for further interpretation that challenges traditional expectations of sensing systems.

2 Related work

2.1 What are sensors?

A sensor is a device that converts a physical phenomenon into an electrical signal. They represent part of the interface between the physical world and the world of electrical devices, including force, chemical, capacitive, and humidity. A fundamental achievement in electronic sensor design is to characterize a model to predict its behavior [Tartagni 2022]. The data processing of sensors is governed by a *transfer function*, which represents the relationship between the physical input signal and the electrical output signal. For example, in an accelerometer, the relationship between voltage and acceleration can be expressed as: $V(Acc) = 1.5V + (Accx167mV/g)$ [Wilson 2004].

This algorithmic processing offers so-called solidified knowledge [Baird 2004]. Meanwhile, system designers using sensors also impose their own frameworks on sensing, as the processed data used to represent a specific phenomenon can differ significantly from the raw data [Benford et al. 2005]. Scientific instruments provide a collective, shared perspective that is often clearly predetermined by their design [De Boer et al. 2018]. To rethink alternative forms of sensing, we need to challenge the fundamental design principles of the instruments [Barad 2007].

2.2 Diffraction apparatus against 1:1 mapping

Karen Barad critiques representationalism by introducing the concept of "performativity," as a call to look at the entangled agency between observation, and the observed, to think social and natural together, and take account of how both factors matter [Barad 2007]. They define *diffractive apparatus* as the tool to study these entanglements to rethink the nature of scientific practices. In their framework, the apparatus is not merely a tool for observation but an active participant in the knowledge production process. This perspective of observer-observed entanglement informs our practice in re-imagining sensing systems. We aim to propose possible ways to encourage humans to also become an apparatus, actively engaging

Figure 2: Activities and process of the exploratory workshop.

in the measurement process, and experiencing the entanglement and the phenomena they are observing.

One approach to rethinking representationalism, as developed by researchers, is to challenge the notion of 1:1 mapping by designing interactive systems that incorporate ambiguity, and reflecting uncertainty [Di Lodovico et al. 2025]. For instance, Reed et al. present a digital musical instrument that utilizes EMG signals with intentionally ambiguous responses [Reed et al. 2024]. Similarly, Eloquent Robes transforms heart rate data into abstract, colorful projections on the wearer's body, promoting self-observation by steering clear of prescribed interpretations [Núñez Pacheco and Loke 2014]. These approaches emphasize affirmation over self-improvement, exploring alternative desires through abstraction in design [Howell et al. 2018; Sanches et al. 2022]. These practices against 1:1 mapping inspired our design of environmental sensing, incorporating ambiguity.

2.3 AI as a resource for contingency

Designers often view the uncertainty of AI as a barrier. However, this uncertainty can be seen as an opportunity, as the output of neural networks not only provides certain information for identification but also embodies uncertainty, offering what can be described as "ontological surprise" [Benjamin et al. 2021; Leahu 2016]. Large Language Models (LLMs) exhibit emergent properties that distinguish them from smaller-scale AI models. Recent research highlights its emergent abilities in two key aspects: its sharpness, which refers to the abrupt transition from absence to presence, and its unpredictability, as they manifest at seemingly unforeseen scales of the model [Schaeffer et al. 2023]. This "unpredictability" is the quality we aim to achieve in our alternative sensing representation. Previous artwork has treated LLM as a medium for emergent art practice, such as in emergent narrative [Wu et al. 2025, 2024]. These concepts inform our strategy of employing LLMs as a medium for data processing within the sensing system.

3 Exploratory workshop

We first conducted a workshop to explore the link between human environment perception and related movement.

3.1 Aim, participants and location

The first two-hour exploratory workshop was conducted in April 2025. It serves as our initial inquiry into sensor sensing, exploring how humans can measure environments without traditional sensors and express their perceptual knowledge through alternative forms beyond numerical values. This workshop was held in Epping Forest (UK), a woodland environment at a seasonal threshold between winter dormancy and early spring regeneration. The group had seven participants, most of whom had experience with movement-based practices. Their professional backgrounds included three painters, three theatre directors, and one curator.

3.2 Procedure and activities

The workshop consisted of three activities. The first activity took inspiration from Kate McLean's sensory map activities [McLean 2019]. This method encourages participants to trace sensed information through walking, capturing its ephemeral nature by drawing maps, which helps the participants articulate their entanglements with the environment. Participants first focused on single sensory modalities – sight, sound, smell, and touch – each explored in separate rounds. In the second activity, participants engaged in multisensory perception of the environment by sensing all modalities simultaneously, and wrote three-line narratives on pieces of fabric. The final activity involved a movement-based exploration led by the workshop facilitator. Based on Rudolf Laban's Effort theory [Maletic 1987], they practiced how to put their physical body with space, weight, time, and flow, as well as levels, directions, and pathways to express their sensing through movement creation. Workshop activities were documented with video and audio, with post-workshop interviews about their expressive methods.

3.3 Findings

The research analyzed participants' sensory maps, written text on fabric, and the video recordings of their movement expressions.

3.3.1 Sensory maps and texts. Participants perceived the act of drawing as a way of having a conversation with the environment. For the drawing on the sensor map(Figure 3), participants proactively explored site-specific materials, such as soil, twigs, stones, and leaves, and incorporated them into their drawings. They also improvised simple symbols—dots, lines, and curves. Based on the

Figure 3: Sensory maps created by the participants during the exploratory workshop

interview responses, these symbols record the participants' interactions with objects in the forest, which significantly shaped their environmental sensing.

On the other hand, the act of writing text is a distillation of participants' personal feelings. Their words reflected not only observed environmental features but also incorporated imaginative layers, including phrases such as "people's discard to the environment," "rupture and destruction," beauty and brokenness," and "I'm the child of the earth." The presence of words like "connection" and "breath" pointed to an embodied awareness, emphasizing how movement deepened their sense of engagement with the environment. Participants also expressed that seeing others' words brought a sense of surprise, while drawing required a second level of understanding.

3.3.2 Movement. Figure 4 maps the analysis of movements, operated on two levels. The first level records the daily behavioral movements that emerged while participants were moving within the environment. Recurring gestures included squatting, hooking the foot, and opening the arms in a broad stretch. The second level examines more deliberate sequences through which participants later expressed their environment measurements. Specifically, their movements converged into three types: (a) directional actions—for example, upward or downward reaches and rotational turns; (b) object-based interactions—such as bracing against, grasping, or circling a fixed object; and (c) small-scale, localized movements—including foot swinging, toe hooking, and other subtle articulations of individual joints. Each category originates from ordinary bodily behaviors that participants deliberately magnified and stylized into expressive movements.

4 The human as a sensor: a critical alternative to 1:1 sensing

The exploratory workshop confirmed that each participant produces unique movement expressions in environmental sensing, perceives the environment in ephemeral ways, and benefits from text as a distillation of their emergent feelings. However, writing can interrupt the ephemeral sensing experience. Similar to human movement, language model outputs are not governed by a fixed input-output relationship. As such, we explore large language models as a means for interruption-free, human movement-based environment sensing.

Based on these observations, we propose a critical alternative to the conventional understanding of sensor sensing. We identified three interrelated agencies in environmental sensing:

- **The Observed**: Drawing from Barad's theory [Barad 2007], this concept refers to the object of observation, embodying the knowledge that exists independently of our observation.
- **The Observation**: The process of knowing, which involves the utilization of instruments designed for measurement, developed within specific paradigms.
- **The Observer**: As the human agent engaged in this process, the observer possesses the agency to interpret and act upon the knowledge garnered from observation.

Figure 5 (left) illustrates the sensing process of traditional sensors. Environmental stimuli (the observed) are detected and converted into signals, represented as x. This signal is parsed into the observation system, which includes the sensor and the interface, and is analyzed using a transfer function $Y = F(x)$. This process outputs signals y, which are numerical, typically presented in a graph. The observer then reads the graph or the numerical data to understand the environment and take further action.

In our approach(Figure 5, right), the human is both the observer and observed, intra-acts with environmental stimuli, leading to unique movements. These movements are analyzed by a language model, which generates intentionally abstract words. These words, being uncertain and contingent, provide references to the observer, without eliciting direct understanding. Knowledge of the environment is reflected in the words generated by the observers themselves. In this observer-observed dynamic, the human becomes the apparatus of observation, collecting and co-producing observations from within their entangled state with the observed.

Concept	Traditional Environment Sensing	Our Critical Alternative
Observed	Environment	Environment ↔ Observer
Observation	Sensor as apparatus	Human as apparatus
Observer	Observer ⟶ Observed	(observer/observed)
Measurement	To detect	To reflect
Result	Specific, determinate, numerical	Unexpected, ambiguous, abstract
Operational	Lead to precise control	Unfriendly to executable systems
Uncertainty	To be avoided	To be welcomed
Agency	Clear and settled	Dynamic and unknowable

Table 1: Comparison of the Traditional and the Critical Alternative Sensing Systems

Our proposed sensing system can draw a comparison with the concepts from a traditional sensing system, demonstrated in Table 1. *The observed:* Both traditional environmental sensing and our critical approach aim to acquire knowledge from the environment. However, our approach emphasizes that the environment is not an isolated entity: understanding it reflects the observer's unique engagement.

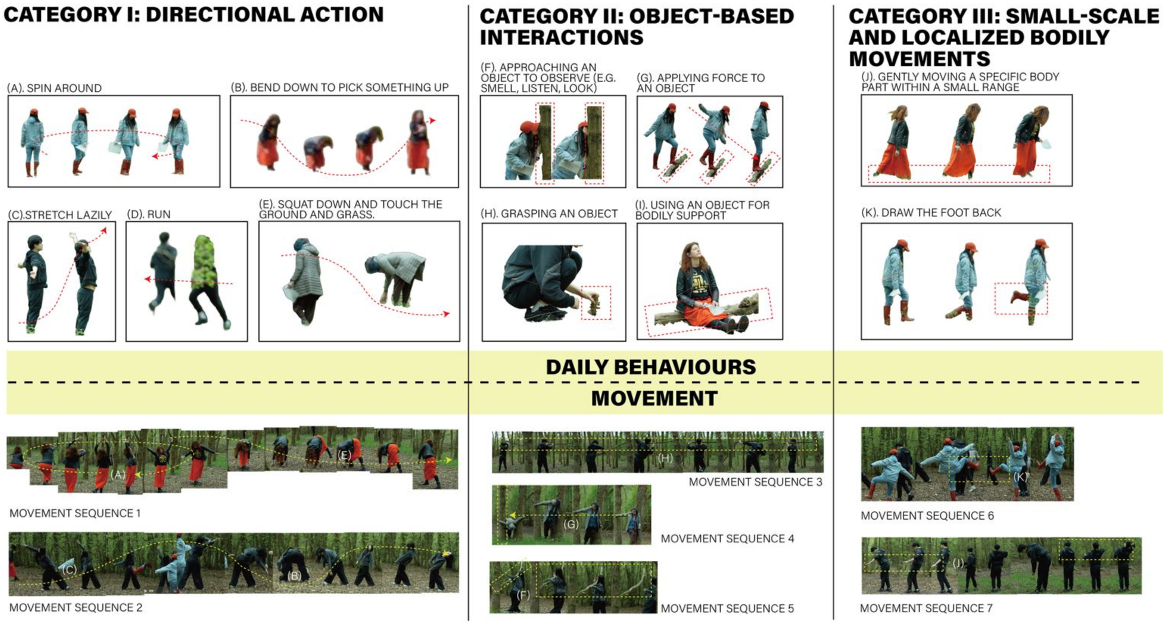

Figure 4: Movement analysis of the exploratory workshop

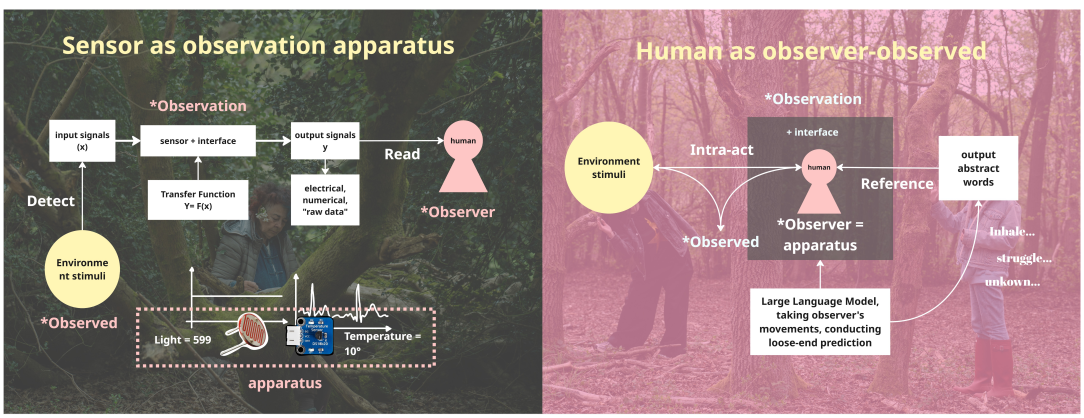

Figure 5: Conceptual framework comparing traditional environment sensing, and our proposed alternative way of treating humans as sensors.

Observation: While traditional environmental sensing delegates observation to sensors, in our approach, the observer and the observed become an entangled entity. The activity of measuring is not to detect, but to reflect. While uncertainty is the key element to avoid in traditional sensing, it is welcomed in our approach. The result is not a specific output distilled from the environment, but unexpected variants unique to each "observed-observer" relation.

For observer: Traditional sensing systems provide data that facilitates immediate further actions. For example, data from a temperature sensor can be programmed to turn off the air conditioning if the room temperature exceeds 25°C by a human. In contrast, our critical alternative does not emphasize executable systems. Instead, it focuses on abstract concepts that aim to inspire deeper understanding and reflection, encouraging a more thoughtful engagement with the data rather than immediate action.

5 Prototype

We developed a prototype system to illustrate our critical alternative. The system observes the body expression of a human sensor/observer and provides contingent text output. It establishes a feedback loop, where the human user alternates between being observed and the observer of their own embodied expression.

5.1 Generative rationale

Following our rationale to avoid 1:1 mapping, we minimize direct movement labeling. Instead, we use movement coordinates as the system input. Additionally, isolating sensory experiences and interacting with site-specific objects helped participants focus and enhance their movement creation. We thus established them as input parameters for the generative system.

5.2 Technical pipeline

Figure 6 demonstrates the interface and pipeline of the prototype we developed. Real-time data of body keypoints is captured by a webcam, utilizing P5.js and PoseNet in ml.js [1] (as shown in Figure 6-A). For specific sites, when using the system, we manually input the coordinates of potentially interactive objects. The system calculates the distance between the body skeleton and the objects (Figure 6-B, as illustrated in the example interface with the stone wall). The program automatically adjusts the sensory expression, guiding the performer's expression based on the indicated sensory modality. This information appears in the form of body tracing color changes as well as text prompts in Figure 6-C. These three types of information are input into LLM 1 to produce a word list, displayed on the corresponding body keypoints, as shown in Figure 6-D.

The word list, accumulated over time, is parsed into LLM 2 to compose a short narrative, presented in Figure 6-E. The approximate location of the performer's body keypoints used to generate the vocabulary is visualized in Figure 6-F, with timestamps indicating when the generation occurred of the two LLMs separately.

6 Dataset development and LLM fine-tuning

To produce a generative framework tailored to movement and text expression to environment sensing, we conducted several workshops, aiming at collecting movement-language associations with environment perceptions, and creating a dataset to fine-tune the probe's underlying LLM.

6.1 Data collecting workshops

6.1.1 Aim, participants and location. The data collection workshops, conducted between May and June 2025, aimed to co-develop a dataset for training the language model system with experienced movement dancers. This process comprised two sessions. A three-hour workshop was conducted at Tate Riverside and Tate Front Plaza, London, UK. Tate Riverside is situated at the boundary between natural and artificial landscapes, providing a unique setting during low tide. In contrast, Tate Front Plaza represented a fully urbanized environment, characterized by heavy pedestrian flow, proximity to landmark architectural structures, and a persistent urban soundscape generated by crowds and traffic. Another two-hour workshop took place in Leake Street Graffiti Tunnel, an urban site notable for its strong association with underground culture. A total of five professional choreographers participated in the workshops, with three attending the three-hour sessions and two attending the two-hour sessions.

6.1.2 Workshop activities. At each site, activities were divided into two parts. First, participants isolated different sensory modalities – smell, sound, touch, sight, humidity, and temperature – to express their perceptions through movements. They were asked to differentiate their bodily responses, convey the sensations using descriptive language during the movement, and speak out loud when they felt the urge. For each sensory modality, each participant designed at least three movement-word sets. In the second part, participants were asked to engage all senses simultaneously to measure the environment, to perform a full movement sequence with a consistent expression, and finally to explain this expression by composing a three-line story. The process was documented with video and audio recordings, supplemented by informal interviews about the reasoning behind their word choices, and the insights gained from this environmental measurement approach as choreographers.

6.2 Findings

We observed the same three principal movement strategies as in the exploratory workshop: (a) directional actions, (b) object-based interactions, and (c) small-scale, localized movements. During the workshops, each participant developed a personal method for converting environmental measurements. Even when working in the same setting, every human "sensor" generated a distinct textual dataset, confirming the notion of unique entanglement between the observer and the observed. Participant A preferred directional language linked to the sensing practice. For instance, during the "smell" task near a rubbish bin, she used the word "backward" to describe how her core instinctively moved that way, even though she didn't consciously perceive the odor. Interestingly, participant D's word choices were shaped by her physical condition, as she was experiencing a cold during the workshop. She consistently described her body parts using terms such as "uncomfortable," "glued," "dizzy," or "heavy." While other participants paused to speak, Participant E verbalized sensations throughout her movements. She believed that words expressed in stillness reflected a sculptural, fixed feeling rather than a dynamic, movement-based experience.

6.3 Dataset development and LLM fine-tuning

The researcher analyzed the movement sequences and corresponding textual descriptions from video of the second workshop, resulting in a dataset structured for interfacing with the Large Language Model's fine-tuning pipeline, comprising user prompts, system prompts, and assistant replies. Figure 8 demonstrates the movement analysis, the dataset obtaining process, and the dataset structure.

Initially, we selected video segments that featured clear reporting vocabulary, extracting a total of 153 movement screenshots. To obtain the skeleton keypoints, we utilized PoseNet in ml.js [2] and employed a P5.js script, deployed on a local computer to capture and store the keypoint data into a CSV file. Body keypoints focus on the core, the head, hands, knees, feet, and elbows. We included details on whether users interacted with objects and the names of those objects as the second labeled item in our dataset. The third item pertains to the sensory modality that participants isolated during the workshop. Together, these three items constitute the user prompt of the dataset(Figure 8, left).

In the system prompt, we included a brief description of the site where the source movement was produced, such as "public square

[1]https://github.com/ml5js/ml5-library/tree/main

[2]https://ml5js.org/

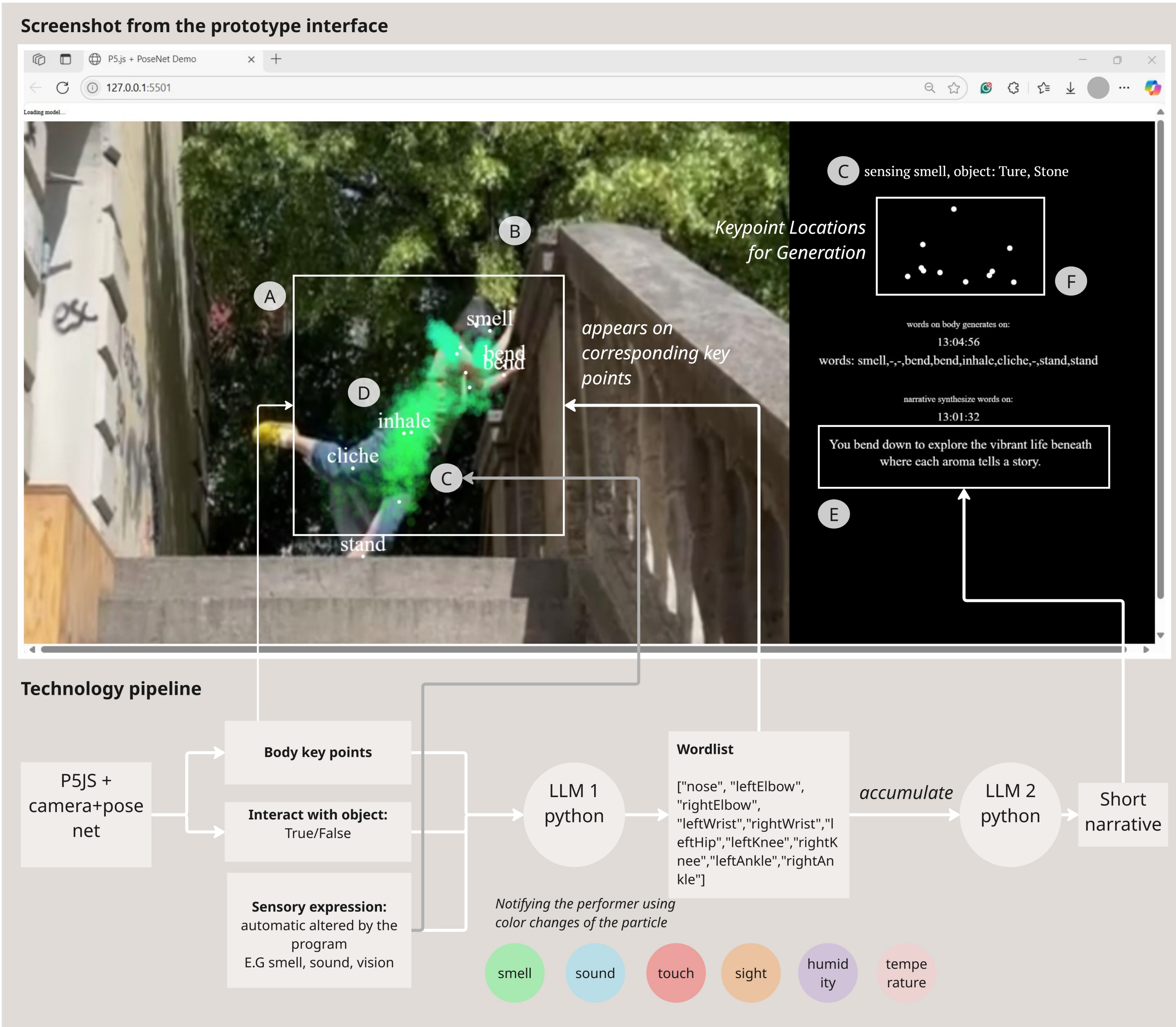

Figure 6: System interface and technical pipeline of the critical alternative sensing system

in front of the state modern"(Figure 8, middle). For the assistant reply, the researchers labeled the words reported by workshop participants according to the corresponding body parts, formatted as ["head", "leftElbow", "rightElbow", "leftWrist", "rightWrist", "leftHip", "leftKnee", "rightKnee", "leftAnkle", "rightAnkle"]. If no reporting vocabulary was provided for a movement, a dash ("-") was used as a placeholder(Figure 8, right). The resulting dataset consists of 153 items, which were parsed into the fine-tuning pipeline based on gpt-3.5-turbo-0125.

7 Performances

We conducted four performance recordings with a movement performer to illustrate the critical alternative to traditional sensing using body expression, and the intra-action dynamics of the system.

7.1 Performance process

The performance was conducted as an exploratory attempt, documenting the effects that the system may exhibit, and applied as media for collecting preliminary feedback regarding this system. The performance consists of two sessions. One session took place in a grassy area within a park with two audiences. This performance focused on sensing smell only. The system was installed on the performer's laptop, and the performer intermittently views the

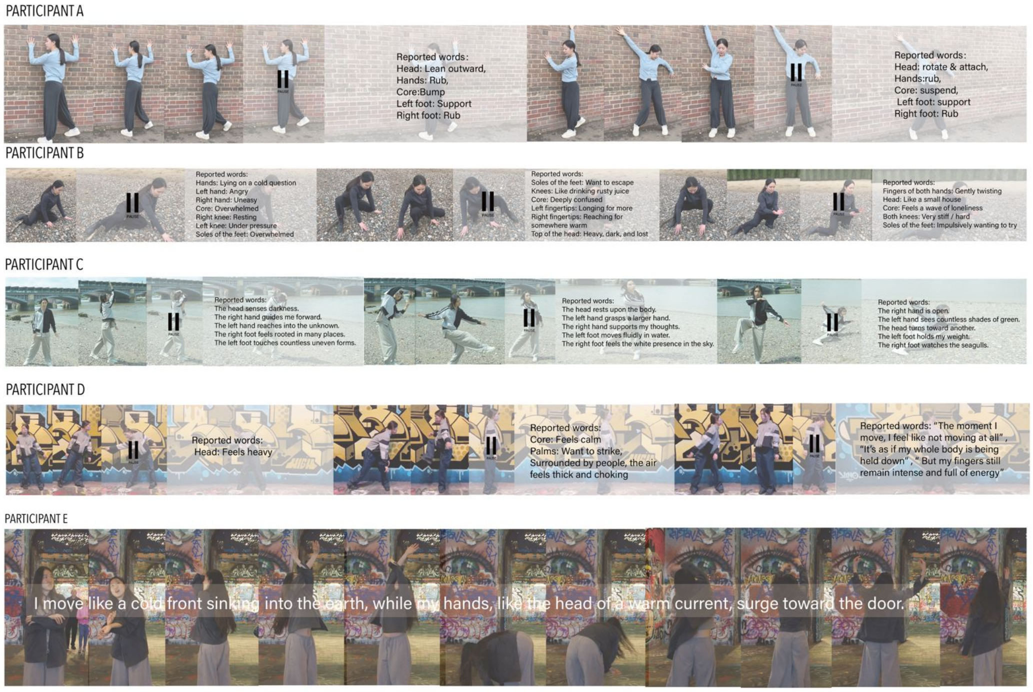

Figure 7: Process of the data collection workshop

Figure 8: Example movement analysis of the six sensory modalities, with the labeled keypoints. Keypoints, object interaction, and sensory modality are combined as user prompts. Words reported by the participants are kept as assistant prompts.

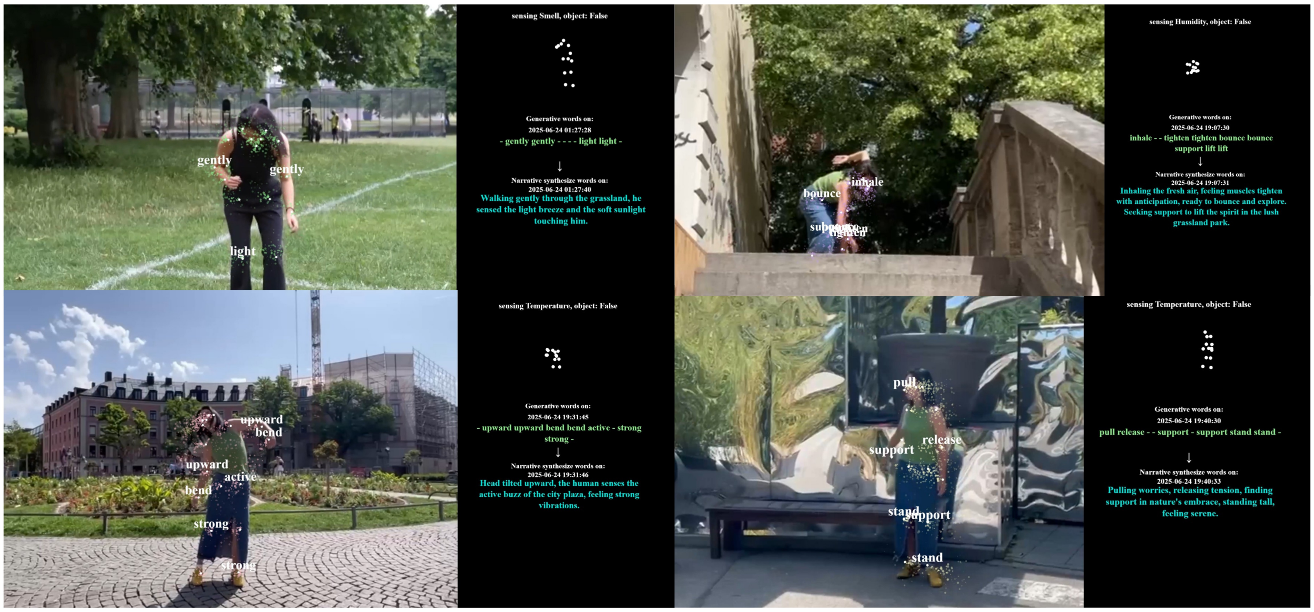

Figure 9: Screen shots from the four performance recordings.

text on the screen during the performance. Given the limitation of screen size, the audience was assigned a participatory role by reading aloud the text generated in real time. This action allowed the performer, even when away from the screen, to receive the text emerging from her movements. After the performance, the audiences were invited to try the system, using the tool to express their own environmental measurements.

Another session involved the same performer, who self-recorded the performance in three locations in Munich, Germany. The performer first recorded the performance video using the sensing measurement method and then processed the recordings using the system. Sites include 1) a random staircase in the city center, surrounded by construction sites and streets, 2) a grand plaza in the city, bustling with pedestrians, 3) a parking lot behind an art gallery. The processed performance recordings were sent to two participants from the data collection workshop for further feedback.

7.2 Audience feedback

Audiences in the first session expressed a desire for a deeper interaction with AI, wishing that the textual meanings could convey greater depth and narrative nuance. In the second session, the audiences reported that the generated words broadly aligned with the performer's movements in the video, yet they offered differing interpretations of agency. One participant suggested that if words were displayed in real time, they might guide the dancer's subsequent actions, creating a bidirectional feedback loop that could diminish the performer's agency. In contrast, another participant noted that the slight delay in word generation could positively influence the texture of their movements, as the words would reference previous gestures, thereby extending the memory of earlier actions.

Participants appreciated the clean visuals the interface presents, focusing on text. However, one noted that the current imagery fails to convey a sense of human-machine integration, seeming more like a mere data capture and transmission. They suggested future the system can integrate a subtle AI-generated voice to report the words generated, as feedback to the performer.

8 Discussion

8.1 Choreographic Insights from the Human-Sensor method

During the research process, our critical alternative reveals its impact on performance and creative arts. In the data-collection workshop, participants were asked to act as "human sensors" to measure the environment. The approach involved decomposing sensing by focusing on one modality and one body part at a time (e.g., head, hands, knees, ankles). All five professional choreographers noted that this approach differed significantly from their usual practice, where perception and movement are typically addressed through the body as a whole. Translating those sensations into words compelled them to expand their perceptual field and reconsider how such micro-experiences could inform subsequent choreographic decisions. Several remarked that they had "never thought about what the left or right knee might feel" before this exercise. The contribution from our reflection on sensing, to the inspiration for choreography, was an unexpected outcome for us.

8.2 Future work

The current prototype serves as a demonstration of the proposed critical alternative. Future exploration is needed to validate the idea of humans as sensors through further artistic practices in collaboration with performers. We envision more immersive spaces and forms that align with the internal feedback loops of performers, particularly given that the current computer interface does not allow for simultaneous text interpretation and performance. It is essential to consider how to integrate these elements into uninterrupted performances, as mixed media approaches like projection mapping could more effectively enhance the experience. Additionally, developing a more user-friendly interface for artists and open-source solutions is crucial to support the system application in the performer's practice. Furthermore, future work will investigate how individuals without movement experience can utilize this as a tool for movement practice, exploring its adaptation into their daily activities as a means of sensing the environment.

9 Conclusion

This paper introduces a critical alternative to traditional environment sensing by treating the human observer as the sensor. Through an exploratory workshop, movement and text were applied as an alternative representation of environmental information. This critical alternative leads to the development of an LLM-driven generative system. Serving as a creative tool for site-specific embodied practices, this critical system aims to shift the dynamic from observer (the actor making the movements) to the observed (the sensed environment), reflecting the environment onto the performers themselves.

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