From Movement Memories to Robotic Dialogue: A Language-Mediated Pipeline for Somatic Machine Translation

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Figure 1: A custom-built robotic interface for *Somatic Machine Translation*. The interface captures and interprets a movement sequence from a human, and generates new robotic expressions with the captured movement qualities.

Abstract

Human movements recalled from memories are often fleeting, private, and difficult to externalize for reflection. Traditional body-centered therapeutic practices, such as Gestalt-based approach, rely on re-enacting a movement as remembered. We propose Somatic Machine Translation, a language-mediated pipeline behind a robotic artwork that captures human re-enacted movements from memories via an Inertial Measurement Unit (IMU), interprets them into natural-language descriptions using a large language model, and then generates new robotic movement sequences. This transformation reframes movement through the body of a non-human performer—a robotic sculpture. We situate this work at the intersection of therapeutic dreamwork, creative AI and embodied interaction, arguing that interpretive divergence can open novel perspectives on somatic memory. The contribution includes a language-mediated robotic movement generation pipeline embedded in the artwork, and a conceptual framework for physical transformation in creative embodied AI.

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1 Introduction

Human experiences often carry not only visual and auditory imagery, but also vivid kinesthetic sensations of movement and bodily presence. Kinesthetic imagery is a primary aspect of human experiences [Nielsen, 1992] and is often central to therapeutic practices [Gendlin, 1986]. In body-centered dreamwork therapies such as Focusing [Gendlin, 1986] and Gestalt-based approaches [Holzinger et al., 2021], participants are encouraged to physically re-enact movements from dream memories as a way of accessing the felt sense of the experience. Revisiting bodily movement and sensation from a new perspective [Holzinger et al., 2021, Bosnak, 2003] can evoke unexpected recognition, reframe bodily memory, and open space for novel interpretations.

However, movements are often ineffable, resisting easy externalization or reflection in waking life. Research shows that observing another body's movement can activate the observer's sensory–motor system and evoke an internal re-experiencing of that movement [Calvo-Merino et al., 2005, Rizzolatti and Craighero, 2004]. This raises a provocative question: *how might experiencing one's own movement qualities reflected back through the movements of another body, particularly a robotic one, reshape emotional and cognitive understanding?* To explore this question, we present a prototype that performs what we call **Somatic Machine Translation**, a language-mediated interpretive layer that links machine understanding and generation of movements: 1. **Capture**: The participant re-enacts a movement from memory, recorded via an inertial measurement unit (IMU). 2. **Interpretation**: A Large Language Model (LLM) generates a natural-language description of the movement's qualities. 3. **Generation**: LLM draws from descriptions of the qualities of movement and generates new movements expressed by a custom-built robotic sculpture.

We generate new robotic movement instead of static playback of movement, to create a reinterpretation that refracts the original movement through another non-human "being" (the robot), rather than mere replication. The predictive processing theory in cognitive science suggests that unexpected variations disrupt habitual perception and bring underlying information into awareness [Clark, 2013]. Thus, the *interpretive divergence* of movement and slight *otherness* from the generative robotic movement have the potential to defamiliarize the participant and surface underlying qualities of the movement. This transformation enables the robotic sculpture as a partner in a *somatic dialogue*, encourages reflection and re-engagement, and externalizes bodily memory from the subconscious in a tangible, physical form.

Our contributions are:

- A conceptual framework of Somatic Machine Translation for body-centered movements
- A robotic prototype demonstrating a pipeline for language-mediated embodied transformation
- A design space for using interpretive divergence—rather than replication—as a creative and reflective tool in embodied AI systems

By reframing robotic movement generation as a process of interpretive translation rather than accuracy-driven reproduction, this artwork invites new possibilities for engaging with memory, reinterpretation, and the body in both art-science and therapeutic contexts.

2 Related Work

Movement-Focused Therapeutic Practices Movement-based therapies, such as psychodrama [Moreno, 1946] and sensorimotor psychotherapy [Ogden et al., 2006], view re-enactment as a medium for integrating unconscious material. Somatic approaches to dreamwork similarly emphasize engaging with the body to access the "felt sense" of a dream [Gendlin, 1986]. The Focusing approach [Gendlin, 1986] treats bodily sensations as carriers of implicit meaning, while the Gestalt-based method [Holzinger et al., 2021] encourages re-enacting dream scenes to surface emotional and symbolic insights. These practices underscore the significance of movement in the process of meaning-making. Our work extends these ideas by exploring how non-human embodiment, in the form of a robotic performer, can reframe remembered movements.

Movement Computing and Language Body movement is deeply intertwined with linguistic expression [Bannerman, 2014], and significant expressive gestures can reveal intent, emotion, or state of

Figure 2: (Left) Close-up of a rotating aluminum arm mounted on a motorized joint. (Right) Custom wearable interface with integrated IMU sensors, worn by participants to capture body movement for language-mediated robotic motion generation.

mind [Karg et al., 2013]. This expressiveness can also be harnessed in robots to create motion that feels meaningful and legible to humans [Venture and Kulić, 2019]. Movement computing typically describes expressive motion using low-level descriptors—kinematic and dynamic measures (velocity, acceleration, jerk)—and high-level descriptors that capture abstract qualities, as in Laban Movement Analysis (LMA) [Larboulette and Gibet, 2015, Davies, 2007].

Motivated by the intrinsic coupling of movement and language, we propose a language-mediated interpretive layer that links machine understanding and generation of movements. Rather than mapping movement directly to numerical parameters, we first translate it into descriptive, poetic language that reframes the gesture before it is re-embodied by the machine. This opens space for reinterpretation, allowing the robotic motion to diverge from direct replication and evoke new meanings.

Expressive Robotic Movement Generation Prior work on expressive robotic movement often maps human posture or motion directly to control parameters of robots. For example, in swarm robotics, a performer's tracked body movement can be translated in real-time into swarm formation and trajectory parameters, such as position, scale, and rotation [St-Onge et al., 2019]. More recently, machine learning-based approaches have emerged that aim to transfer the underlying expressive features from human to robot motion. These methods use convolutional autoencoder–based fusion networks [Osorio and Venture, 2022] or variational autoencoders (VAEs) combined with generative adversarial networks (GANs) [Osorio et al., 2024], to capture and synthesize expressive movement styles across embodiments. Building on this trend of expressive movement through generative models, our work explores a large language model for movement interpretation and generation. This process aims at creating an artistic playground for exploration: to see what new patterns or insights might emerge through interpretation, and what perceptions or emotions they might evoke in the participant.

3 An Embodied Artificial Intelligence System Making Sense of Movements

Our prototype implements Somatic Machine Translation through a custom-built robotic interface (Figure 1). We intentionally built a minimal and legible robotic sculpture: three slender aluminum bars, each with a single rotational degree of freedom. We are using a Dynamixel XM430-W210 smart servo to provide the motion, controlled by an Arduino Uno with a Dynamixel shield. Each bar is a 6-foot U-channel structure, connected to the motor and a standing pole via 3D printed connectors (Figure 2 left).

The movement of the participant is recorded through a wearable device, with an Adafruit BNO055 IMU sensor attached (Figure 2 right). Wearing the device on the torso, the participant is invited to re-enact a sequence of movements from dream memory to start an embodied dialogue with the robotic interface. The live-streamed IMU data is communicated from Arduino to Python via serial communication and integrated as prompt input into our AI pipeline.

The AI pipeline is composed of two LLM (GPT-4o) modules: one movement interpretation module and one movement generation module. This language-mediated interpretation and generation pipeline

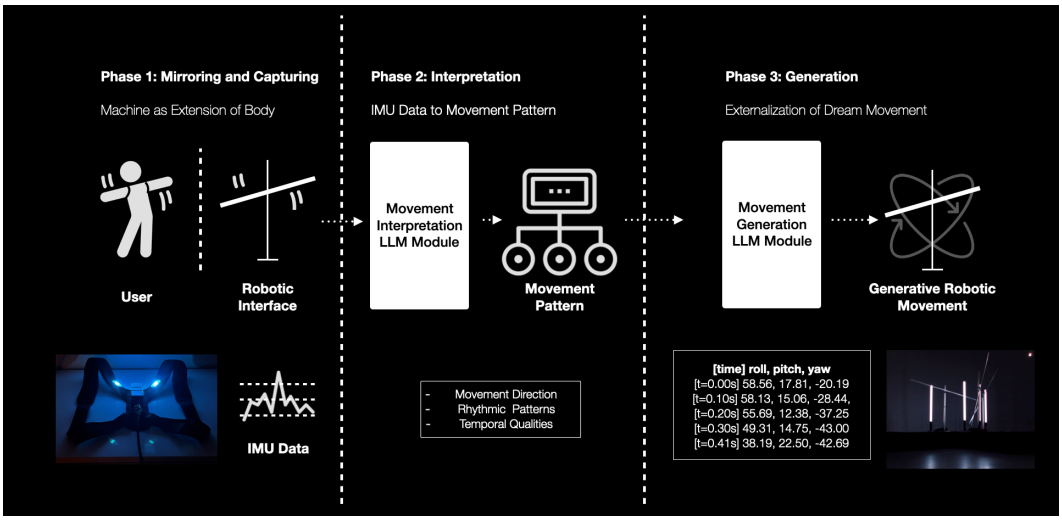

Figure 3: System workflow for language-mediated robotic movement generation. Phase 1: Mirroring and Capturing — the participant's body movement is mirrored by a robotic interface and recorded via wearable IMU sensors. Phase 2: Interpretation — IMU data is processed by a movement interpretation LLM module, which extracts directional, rhythmic, and temporal qualities as movement patterns. Phase 3: Generation — a movement generation LLM module re-embodies these patterns through a robotic performer.

transforms human re-enacted movement into a new robotic performance through three phases (Figure 3):

3.1 Phase 1: Mirroring Movement as an Extension of Body

In the first phase, the robotic sculpture functions as an extension of the participant's body. The participant wears a custom-built IMU-based wearable positioned at the center of the back, near the torso's center of mass — a location that captures the core dynamics of whole-body movement. Raw motion data is recorded in 5-second windows (sampled every 100 ms) to capture the style of a single movement phrase. The wearable not only measures orientation, acceleration, and gyroscopic data, but also anchors the sense of embodiment for the participant. Placing the sensor close to the body's core enables the robotic system to capture dominant bodily motion in a minimalistic setup.

While capturing bodily motion, the robotic sculpture simultaneously follows and mirrors the participant's dominant movement. This stage serves two purposes:

1. **Familiarization & trust-building.** Participants experience the robot as a responsive partner before it introduces interpretive variations.
2. **Somatic anchoring.** Mirroring reinforces the link between body memory and external artifact, bridging internal sensation and external perception.

Framed as an extension of the body, the robot is initially positioned as an amplifier of the participant's existing bodily narrative, setting the stage for later transformation.

3.2 Phase 2: Human Movement Interpretation and Sense-making

The second phase shifts from embodied extension to semantic interpretation. An LLM interpretation module receives this time series data and generates a qualitative movement description. When choosing which descriptors and movement qualities to emphasize, we favored features optimized for human perception and for generalization across varied morphologies. While Laban Movement Analysis remains one of the most extensive frameworks, [Osorio et al., 2024] highlights practical hurdles in using Laban annotations with diverse embodiments. Furthermore, [Wallace et al., 2024] identified low-level descriptors such as speed, acceleration and smoothness of movement as most

influential for perceptions of intent and inner state. As a result, we decided to choose temporal qualities (speed, acceleration, smoothness), rhythmic pattern (circle, bounce, sway), and movement direction (forward, backward, left, right, up, down, turning).

By translating numerical kinematic data into human-readable descriptors, the system creates a linguistic bridge between bodily sensation and symbolic reflection. Beyond description, this step supports sense-making, allowing participants to view their movement in words and to integrate it interpretively and narratively.

3.3 Phase 3: Generative Movements via Robotic Expression

The third phase moves from description to generation. The LLM takes the qualitative description from Phase 2 and transforms it into a new movement expression, guided by a computational grammar of motion primitives (e.g., oscillate, arc, spiral, pause, and rebound). Two key design principles shape this generation:

Interpretive divergence — The new movement maintains certain qualities and styles from the original (e.g., acceleration bursts and rhythmic cycles) while creating new variants of the movement that probe expression and invite reflection.

Co-creative choreography — The robot's movement is not an output for mere replication, but an offer in an embodied dialogue based on the interpretation stage. Participants can respond, mimic, or contrast the robot's new phrase, forming an iterative exchange.

This final phase repositions the robot from an extension of the body (Phase 1) to a co-creative partner with machine agency, generating unique movements that are both novel and familiar, and prompting new bodily and emotional insights.

4 Robotic Interface as Co-reflective Partner

While mirroring and reproduction of movement can reinforce bodily recognition, it often remains a one-way act. By contrast, our artistic framework treats the robot as a dialogic partner: it receives the human's movement, interprets it through language, and responds with a transformed embodiment. This human-robot interaction invites the human participant to respond in turn, producing a cyclical and co-creative choreography.

By generating new movements that reflect the pattern and quality, the robot refracts the original movement through a different body and physicality. By altering the lens of interpretation, the reframing can reveal otherwise unnoticed qualities in the original movement. Within the context of body-centered therapeutic practices, these differences may catalyze recognition, provoke surprise, and encourage reinterpretation.

Philosophically, *Somatic Machine Translation* engages with questions of non-human perception and material interpretation. By passing human movement through a linguistic and mechanical other, the process exposes the subjective nature of translation across modalities. Here, "productive mistranslation" becomes a creative strategy: the robot's differences are not errors to be corrected but offers to be explored.

For creative AI, the role of generative systems in embodied settings shifts from accuracy-focused reproduction to co-creative interlocution: systems that absorb and transform human expression, offering it back in revised form to elicit reflection, improvisation, and embodied insight.

5 Embodied AI in the Age of Language Models: New Dimensions and Ethical Implications

The emergence of large language models redefines how machines can interpret and generate human-like narratives, metaphors, and descriptive language. In traditional robotics, embodiment has often been framed as the ability to sense and act in the physical world, guided by numerical control systems or symbolic reasoning. In the age of LLMs, however, embodiment gains a new dimension: the ability to filter physical experience through a linguistic lens, producing interpretations that are not merely functional but richly textured.

This shift creates both possibilities and tension. Language offers a flexible medium for abstraction and reimagination: a movement can be reinterpreted in words, reframed in imagery, and re-embodied in forms that invite surprise, rather than reproduced with mechanical exactitude. This capacity resonates with artistic and therapeutic practices where transformation and reinterpretation are more valuable than faithful reproduction. By letting a robotic body "speak" in the language of metaphor before it moves, we can create interactions that are less about command and execution, and more about co-creation and discovery.

On the other hand, language-mediated embodiment also raises questions about interpretive power and authorship. An LLM's description of a movement is never neutral—it is shaped by the biases of its training data, the prompt design, and the cultural assumptions embedded in language itself. This can both enrich and distort the personal meaning of a movement. The artistic potential lies in embracing this interpretive divergence as a generative force, while remaining attentive to how it reframes the narrative of memory.

In this light, embodied AI in the age of LLMs is not simply a technical frontier, but a cultural one. It challenges us to think of robots not as silent executors of motion, but as partners capable of re-imagining human gestures through the interpretive richness of language. This opens a space where bodily memory, machine translation, and physical re-enactment intertwine, creating an expanded field of embodied dialogue between human and non-human agents.

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