

Digital Twin Framework within the Structure of Educational Advancement and Physical Storage of Intangible Artistic Dance—An Empirical Investigation into the Recognition and Utilization of Cultural Archetypes within Baima Tibetan Dance

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Abstract: As the characteristics of intangible cultural heritage conservation have evolved, the field has transitioned from an “urgent documentation” stage into a novel era of “innovative transformation and creative advancement”. Simultaneously, a primary challenge has emerged: have we genuinely unlocked the deep “black box” of dance as a dynamic artistic expression? Baima Tibetan dance within Sichuan Province serves as a representative instance that this study will utilize to introduce the modern digital twin concept and propose a structured framework for establishing a “digital bodily database” of intangible cultural heritage dance. This repository is not simply for archiving images and videos, but instead seeks to create an accessible, interactive, enduring and living digital representation that can preserve the transient cadence of the material realm while also preserving cultural recollections intimately tied to the dancers’ flesh, essence, etc. The primary objective of this research is to discover a dependable method to isolate the “cultural archetypes” embodying the essence of a tribal community from the high-resolution digital bodily archive, and subsequently investigate how these archetypes can bridge the digital realm with the real world to infuse fresh vitality into contemporary dance pedagogy. Numerous aspects of the project involve connecting the ancient physical wisdom of the past to the future trajectory of education. It might not merely pertain to technology; it is also adjacent to the philosophical basis of vibrant transmission of intangible cultural heritage.

Keywords: Cyber twin; Physiological repository; Cultural archetype; Baima Tibetan dance; Intangible cultural heritage; Pedagogical development

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1. Introduction: Where ancient dance meets the digital age

Over millennia, the ritualistic dance Tiao Cao Gai of the Baima Tibetan tribe has been performed around bonfires beneath the night sky. Wearing menacing wooden masks, the dancers stomp and leap in mid-air. Each motion is not merely a physical gesture but a silent narrative etched in flesh; it represents an ancient chain connecting heaven, earth, humanity, and spirits. Nevertheless, as the guardians grow older and the traditional ceremonial settings vanish in contemporary life, what else can we do but capture increasingly blurred images with cameras? We have preserved the “form” of the dance, yet what about the “soul” that animates it—the unique gestures, the rhythm fused with faith, and the profound system of cultural icons? Have they also slipped into the void of Reels and hard drives?

This suggests that currently, the primary challenge in preserving intangible cultural legacies like dance lies in our excessive emphasis on “conservation” while neglecting the “vitality” inherent in dance ^[1]. The actual process of dance inheritance involves the transmission of corporeal wisdom. It represents a social and cultural endeavor necessitating “practical engagement and physical embodiment,” instead of just “passive observation and viewing,” and with digital twin technology emerging, we now possess promising opportunities. It seeks to transcend being a two-dimensional and superficial display; instead, it aims to create a three-dimensional, immersive “digital replica,” and could we establish a simulated ritual space for Chigezhou? Could the motions of historical vitality be slowed down infinitely, dissected, digitized and restructured within the electronic realm? This is not simply a technological aspiration; rather, it constitutes a profound investigation into the metaphysical essence of dance, and how might we energetically pass down and perpetuate the essence of a specific style of dance within the digital age?

Building upon these aforementioned issues, this research constitutes a pragmatic exploration. The “digital body archive” represents the outcome of multi-dimensional and systematic data modeling within dance ontology. We propose that the “cultural prototype” functions as a distinct “cultural gene” embedded in the kinetic system, providing dance with its unique traits and significance. Utilizing Baima Tibetan dance as a basis, we aim to investigate the entire procedure of high-precision digital mapping and cultural gene decoding for pedagogical advancement and utilization. While it may not provide the sole solution, this effort shall initiate a novel dialogue between the living and the recorded text, between heritage and creativity, between conservation and production ^[2].

2. Theoretical dimension: Reflections on body, archive and digital twin

Investigating the digitalization of dance requires starting with the primary issue regarding the definition of dance itself. Maurice Merleau-Ponty held that our physical bodies are the primary means through which we perceive the environment. Dance further serves as a medium for culture, history, and feelings that can manifest an individual’s character in an alternative manner. Within Baima ethnic dances, there is a powerful portrayal of towering peaks and canyons, and one may perceive the reverberations of the traditional melodies transmitted by their Di-Qiang forebears. This knowledge is “incarnate.” It is discovered in the trembling yet precise gestures of the veteran artists and in the implicit rapport among the ensemble throughout the show. Conventional audio and video recordings are akin to snapshots of an active volcano; while we might observe the picturesque landscape, we fail to feel the intensity inside, the pressure or cadence.

Consequently, establishing a “digital body archive” seeks to transcend simple “documentation” and progress toward “replication”; consequently, motion capture, 3D scanning, spatial audio and various

instruments are employed to document not merely the physical presence but also the kinetic information of movements, patterns of muscular strain and force exchanges between dancers and their surroundings, music, other artists and audiences. This “digital twin” could be utilized to perform numerous diverse simulations, and we may elevate various hypothetical inquiries, such as what would occur to emotional interaction if the pace of activity were altered? If the ritual setting were to shift from a level platform to a virtual icy peak, would there be novel narrative concepts for the choreography? It has shifted from a method of safeguarding legacy to one for investigating and generating ^[3].

“Cultural prototypes” offer valuable insights into our analyzed datasets and provide deeper cultural interpretations. Such prototypes represent structural frameworks, distinct from specific motion styles, forming the core cultural essence of choreography. For instance, within Baima dance, a “circular dance” might be interpreted as a prototype linked to collective unity and cosmic rhythms; “imitative gestures” serve as an additional prototype arising from the foundation of animist philosophy. Consequently, studying these “prototypes” is essential for grasping their methodologies of meaning construction and cultural expression. Thus, the primary objective of pedagogy is currently to develop students’ feelings instead of solely their academic knowledge.

3. Methodological path: forging a “Digital Double” of Baima dance

Establishing a digital archive for Baima Tibetan dance represents a highly specific and reverent multidisciplinary endeavor. Initially, it shall carry out certain fundamental field investigations

Within the villages of Pingwu or Jiuzhaigou regions, whenever the rhythm of Tiao Cao Gai is played, our responsibility goes beyond merely setting up hardware. We engage in profound dialogue with the practitioners to understand the spirits or forebears depicted by every “Cao Gai” mask and the myths integrated throughout the entire performance. Consequently, simultaneously, a multi-modal capture architecture shall be established: high-accuracy motion-tracking bodysuits will document the subtle motions of every skeletal joint within three-dimensional environments; pressure sensors will gather the power and cadence of footsteps on the terrain; 3D laser scanning devices will transform these intricate images and attire featuring enigmatic designs into digital frameworks with millimeter precision; and concurrently, 360-degree panoramic cameras and spatial audio setups will strive to preserve the entire ambiance of the sacred space where the ethereal and the physical intersect during ritualistic events.

Numerous diverse datasets have been gathered within the digital laboratory. Kinematic data is utilized for constructing high-fidelity 3D avatar models, enabling virtual “actors” to conduct ancient rituals within the cyber realm. However, the current scale remains insufficient. The challenge to be addressed is how to animate the knowledge graph. For example, a motion pattern like “a sudden backward lean and shoulder movement” may be connected to the verbal history narrative indicating it “recreates the wrath of a black bear to repel malevolent forces”, a “counterclockwise circular sequence” might be linked to text stating “symbolizes the solar trajectory and the perpetual cycle”, and so forth. Consequently, this dormant database shall start establishing a cultural neural framework, and the inactive “digital prototype” will progressively be converted into a queryable and vivid “bodily archive” ^[4].

4. Prototype analysis: Decoding the cultural codes of bodily movement

Established on this primary framework of the digital bodily repository, we can derive “cultural prototypes” of Baima Tibetan dance with the same accuracy that linguists examine grammar.

Initially, the celestial and terrestrial cosmology characterized by “bending, rising, opening and closing” is presented. Through visualizing segments of the “bear dance” or “lion dance” within Chigezhou digitally, one observes a significant disparity in vertical motions: profound flexions near the floor and powerful vertical leaps. This transcends mere animal mimicry to represent the Baima ethnic group’s “three-realm” philosophical perspective; bending the limbs links the terrestrial plane to the subterranean realm, while elevating the spine aims for spiritual transcendence. It serves as a “spatial archetype” of universal equilibrium manifesting via the human axial framework.

Furthermore, this collective imagery represents a “round and inward” advancement. To investigate the framework of “Fire Circle Dance” within collective digital choreography, one might develop a virtual twin. How do dancers instinctively modify the tempo and tone of music to achieve a flawless loop? Why has the trajectory of movement remained consistent throughout? This highly synchronized “circular and inward” gesture is a form of physical manifestation of “group instinct”, and it encompasses racial cohesion, the cadence of existence and the integration of strength; it functions as a robust “societal bonding paradigm”.

Furthermore, the “Mask-Formula” Structure’s Symbolic Expression. Numerous “Twelve Forms” performances feature standardized gestures for diverse masks, including dragons, tigers, and oxen. An electronic database could assist in recognizing and investigating several instances above. We have noted that there are structured variations in the power, scale, and cadence of various types of motion. A mask is not merely decorative; instead, it serves to make individuals feel like they are divine creatures or foreboding ancestors. The network in question represents an entire “persona-transformation and storytelling model” mask framework.

Identifying these archetypes allows us to recognize societal patterns more clearly for the first time, despite having perceived them instinctively earlier. They are no longer nebulous sensations but interpretable, assessable and even measurable frameworks of civilization.

5. Transformation path: From digital genes to classroom life

The utility of records lies in their utilization; the importance of models resides in their potential for implementation. How might such “cultural legacies” derived from the electronic realm be integrated into the essence of contemporary pedagogy?

Instructional evolution must remain hierarchical, shifting from recognition toward creativity and from understanding to utilization. We might develop a participatory digital pedagogy for performers. Utilizing VR hardware, pupils can immerse themselves in the virtual environment of the electronic Baima community and sense the reverent ambiance of the pre-sacred rites; they can manipulate a computerized version of any dynamic pattern, decelerate it by one-tenth, and examine the force vectors from multiple angles; furthermore, an AI-powered system could function as a persistent instructor to contrast the student-replicated motion with “normative” data and offer accurate comments on positioning and power, etc. In short, researchers could reach the origins of a dynamic phase and discover why such knowledge is essential.

Concerning the advancement of early childhood schooling, the primary emphasis of this project has remained upon creative and informal approaches to instruction. We may establish a kindergarten sports

education program grounded in “cultural archetypes”, for instance, by focusing on the archetype of “circle and centripetal force”, we might develop an exercise named “Our Circle Dance” to enable little kids to sense the equilibrium and cooperation of grasping hands and spinning collectively; analogously, utilizing the theme of “mimicry”, we could arrange a “Forest Animal Carnival” and let preschoolers mimic the postures of bears, lions and various creatures via Baima choreographic gestures, thus enjoying the pleasure of traditional beast-imitative ceremonies. Hereafter, these young teachers shall be capable of integrating Baima heritage components into youngsters’ primary perceptions of the universe in a manner that aligns with their growth in intellect.

It is no longer about presenting several static patterns of ethnic dance, but about guiding pupils to immerse themselves in a vibrant civilization. What they acquire is not stiff prototypes but a linguistic framework that they may utilize independently in their individual compositions. The database of the digital twin plus its cultural prototypes could offer a “lexicon” and a “manual” for profound investigation of the legacy, and the liberty of creative manifestation shall be restored to the artists and educators ^[5].

6. Discussion: Empowerment rather than replacement, dialogue rather than monologue

Consequently, we must stay composed and deliberate. Regardless of how dazzling the technical radiance appears, it should never be misleading. Irrespective of how intricate the “digital facsimile” built via virtual twins is, it remains merely a “simulation” of a structure; it cannot substitute for the genuine intimacy, organic brilliance, and allure built up over years through artists’ careers. It is a highly explicit statement and a precise tool, yet the essence of dance is perpetually housed within that crucial instant prior to the screen.

Consequently, the fundamental ethics of this study emphasize “empowerment” over “replacement”, and “dialogue” over “monologue”. Every digital repository must be grounded in complete informed consent and reciprocal benefit distribution with the Baima Tibetan community and artists. The interpretive sovereignty of these archives must align with the perspectives of the cultural subjects. Digital infrastructures can serve as innovative instruments for preserving traditional heritage, providing researchers with novel avenues of investigation in this field and offering renewed inspiration for creatives; nevertheless, they must not become a detached occurrence that separates traditional culture from modern existence and forfeits its energy.

The aspiration is to realize a “coexistence of the digital and the material”, and the “real-world archive” within the digital space and the “dynamic heritage” at the physical site shall evolve concurrently and reinforce one another. Elderly artists may utilize digital playback to demonstrate the intricacies of bodily expressions more vividly; younger individuals will be motivated to engage in the realm of choreography via digital interaction; and dance innovators can derive prototypes for fresh pieces that are consistent with heritage yet attractive to youthful spectators.

7. Conclusion

From the particles stirred up by the stomping of Baima Tibetan performers to the rhythm on a digital display; from the physical rhythm passed down in ancestral ceremonies to the lively imitation of young people in future schools, our goal is to connect the past and present in space and time. Digital Twin technology can help us observe the sagacity in the bodies of organisms more precisely than before; it is now available. To

build a “physical repository” and recognize “cultural archetypes” is, in fact, to achieve deep “educational evolution”; it is not only about preserving a fading glory but also about cultivating new power for continuous development. When cultural heritage is uncovered and reinterpreted by new forms of media, intangible ethnic dances have begun to develop their own “dynamism” in contemporary society and have left the world of museums for the general public. The path ahead is long and difficult, and we must be cautious; however, all the people who love dance and culture are eager to explore it.

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