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Nogueira, Maria Rita, Menezes, Paulo and Carvalho, José Maçãs de (2022) "F O R M S": creating visual composition through the movement of dance and Artificial Intelligence. In: The Paris Conference on Arts and Humanities 2022 (PCAH2022), 16 June 2022 - 19 June 2022, La Maison de la Chimie, Paris, France.

DOI: <https://doi.org/10.22492/issn.2758-0970.2022.8>

Publisher: The International Academic Forum (IAFOR)

Version: Published Version

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***“F O R M S”*: Creating Visual Composition Through the Movement of
Dance and Artificial Intelligence**

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The Paris Conference on Arts & Humanities 2022
Official Conference Proceedings

Abstract

What relationship exists between dance and visual arts? How can dance visually express lines, shapes, and visual compositions in space? It is true that performing arts and visual arts have common methodologies and connections with each other. However, how can the audience understand their relationship? The present work intersects art with technology, more specifically dance movement, and machine learning techniques, to create a new visual representation of the body's movement in space. The field of artificial intelligence has allowed machine learning techniques, such as human-pose estimation to explore areas of body movement. The integration of machine learning with dance has resulted in different approaches, but how can this relationship contribute to involving the audience? *FORMS* mirrors this dancer-machine dialogue in an interactive installation performance. Body language is the vehicle that drives the visual outcome of the interactive experience, creating a novel real-time visual expression of the dance movement. The hybrid format of the installation offers the audience a live performance and an open experience where anyone can play with *FORMS* through their movement. It contributes to cultivating body awareness, understanding in major detail the dance movement, and enriching the art experience.

Keywords: Dance, Artificial Intelligence, Interaction Design, Human-Pose Estimation

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Introduction

The term *movement* or *kinesthesia* was introduced to Worringer's theory, with aesthetics being expanded to include the changing, throbbing, writhing, dancing, and expressive activity of bodies in space over time (Worringer, 1997). The *movement* and *kinesthesia* sensation of our bodies give us a sense of space. We perceive items' spatial features because we have moved with them. According to (Mettler, 1947), we know a tree is vertical because we've stood next to it and felt the strain necessary to keep it vertical in our muscles.

We only have meaning for these varied spatial shapes because we have experienced movements comparable to those that caused them. *Kinesthesia* experiences make us aware of the spatial links occurring between movements of various body parts (Reynolds and Reason, 2012). A fully embodied experience of art links the intellect with emotions and intertwines time, space and movement. In 1977, Rudolf Laban already mentioned the visual design of the movement, the form in space made by the different body extremities, or the total body can be the essential thought to convey (Hutchinson et al., 1977). The visual shape created may be a path across the floor, a design (trace form) made by the extremity of a limb (e.g. a circle, zigzag, or figure eight), or plastic shapes made by the limbs or the body as a whole. The breaking down of boundaries between dance and drawing as well as the increasing interactions between choreographers and visual artists, mirrored a broad artistic condition in the 1960s and 1970s (Dai, 2016). The dancers' moving bodies generate visual images and this process can be interpreted in terms of effect, where choreography functions as an action of the body on itself and draws attention to this process. The choreographer William Forsythe explored the connection between dance and drawing through movement representation in the space (Forsythe, 2011).

In both dance and drawing, the line releases itself from its perfect form of a merely geometrical element to appear in space as an open, socially integrative element. Forsythe uses drawing to generate new movements and new combinations for dance (Baudoin and Gilpin, 2000). "*Improvisation Technologies*" (Fiorentino et al., 2002) was created to help new ballet dancers understand their choreography and movement language, Forsythe visually illustrates how to construct a line, and slide across a vertical and horizontal line or extrude a plane from a single line. Forsythe started his research by dismantling Laban's model of movement, but he then moved on to explore drawing and notation as an initiator of movement and spatiality (Baudoin and Gilpin, 2000).

On the other hand, Trisha Brown, a multidisciplinary artist through her passion for dancing and visual art stems not only from her interest in the two art forms but also from the contemporary art community's collective artistic state (Dai, 2016). Trisha Brown began a discourse between dance and painting in her 1973 visual works, similar to Kandinsky's pictures of *Palucca* in "*Dance Curves*" (Funkenstein, 2007). Brown used linear and geometric patterns in his compositions to produce abstraction, a style she favors (Rosenberg, 2016). Brown combined the two art forms and used drawing as a tool to develop new dance moves, unlike Kandinsky, who looked at - *Palucca's dancing as an expression of his theoretical beliefs based on abstraction* - and drew from dance images. The meaning and definitions that dance movement can express in drawing, and vice-versa, changes from artist to artist. Nonetheless, it is pertinent and important for the audience to think about the association that two arts can have with each other, or even different areas, thus generating new ways of thinking and exploring creativity and art. Following the inheritance that the mentioned artists have started, as well as others not referred to, the present work "*FORMS*"

aims to merge dance and visual arts, through artificial intelligence, namely machine learning techniques.

Generated visual forms through the dance movement

“FORMS” aims to make an intersection between dance and visual arts, as an aesthetic approximation, in dealing with drawing as movement and dance as choreographic image. The object of study is body movement and the visual dialogue that the different parts of the body establish with each other, as shown in Figure 1. The involvement of technology is the main mediator to establish this relationship of performative translation into visual language. In this sense, the areas involved are dance, visual art, and human-computer interaction through machine learning techniques, namely human pose estimation. The connection between dance and machine learning techniques has numerous exhibit possibilities, from choreographic creation or learning process to interaction with the performer, or personal use. On the other hand, the interactive character that the present work provides allows the creation of an interactive installation open to the whole audience, in an exhibition format involving anyone. Since it substantially enriches the movement of dance, or simple human movements, and gives a new visual perspective and perception about our body.

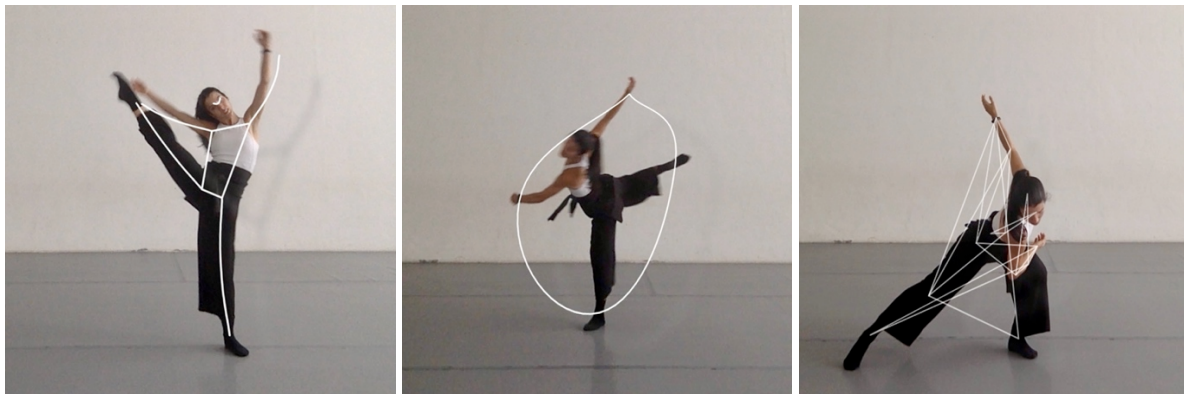


Figure 1: Case studies through the dancer's performance and FORMS. This figure is represented three visual approaches, Literal (1), Bézier (2), and Geometric (3).

Hybrid format

According to previously exhibited art installations, the audience dramatically appreciates the interactive experiences and personalized actions in which the audience sees their reflection or personalization of themselves. Involving the public as performers and being spectators of themselves is one of the main objectives of bringing culture and art more accessible. Conversely, there is also the possibility of the present work being displayed in a performance on the stage, with dance and technology working together in real-time, contributing to a new dimension of performance. By referring to stage and audience, we are automatically mentioning museums and exhibitions, presenting this work as a performative installation. In this format, the audience will certainly be closer to the dancer, and certainly more involved in the installation itself. Finally, the pedagogical contribution that this work may have in teaching dance movement and *kinesthesia* knowledge will provide, from an early age for young dancers, to look at their movements in a more mature way and obtain a greater body awareness. As a tool to support one's own movement, the visual perspective that technology provides allows anyone to look at their own body and movement more consciously. The general public will retain new aspects of the art of dance, coupled with artificial intelligence, and by engaging with the fusion developed will discover new insights.

Technology Development

Our technology model is characterized by its portability since it relies solely on a computer to develop the technology and capture images in real-time. The proposed system is based on the detection of the human body and how this detection can be represented in different visual forms during the performance or interaction. For human body detection, the model integrates the OpenPose system (Cao et al., 2019) which detects body movement in real-time. From this point, we obtain coordinates of the body skeleton in the physical space, which allows the connection between the different body parts in the space. Each identified part of the skeleton corresponds to the *keypoint* of the body part detected in real-time. We have been working with seventeen different *keypoints* of the human skeleton and by detecting them, we explored the possibility of their visual connection, but through different visual forms. First, we studied, conceptually, the visual representation for the interpretation of the dance movement. We started by drawing the most basic shapes that went around the skeletal key points, to find out how these compositions could behave, as shown in Figure 1. From there we connected more distant key points to understand their relationship and how their connection might work visually. Under previous works through dance movement (Nogueira et al., 2019; Nogueira et al., 2021), hand and foot points have a constant connection in classical ballet and contemporary dance, and it's mainly this bodily relationship that we focused on during the visual dialogue.

Methodology

The methodology of the work involves different phases. Firstly, understanding human pose estimation and how to represent the detected *keypoints* into visual shapes, lines, and composition forms. After this stage, we focused on creating the algorithm responsible for visually generating the different visual representations. Once a first visual representation was obtained, we started usability tests with dancing, in real-time. After this first encounter between dance and technology, we began a process of iteration until we found the ideal visual representations and movement studies that expressed the concepts to be addressed in the work. After the technological conception, we reflected on the best way to present the work and it was agreed that the creation of an interactive installation would be the first purpose. The interactive installation is the beginning of an artistic experience and behavior analysis, to understand how the audience interacts in this hybrid format.

Results

The visual representation created reflects the relationship between each body extremity of the dancers' body and the physical space. The movement of the dancer in its spatial form has different representations, from contained movements to more expansive movements. By visually representing the connection of the dancer's extremities, in real-time, the audience can see in more detail the body connection that is required in during a dance performance. The representations explored were based on three distinct approaches: *Literal (1)*, *Bézier (2)*, and *Geometric (3)*. A *Literal* approach approximates the shape of the human skeleton or a sketch that surrounds the dancer's body. *Bézier* generates curvilinear shape in an abstract form, throughout the performative experience, in which the visual representation involves the dancer as a shadow or a crisscross of lines. The premise is the presence of the body, through an abstract form that engages with the virtual environment itself, leading to the ambiguity of the virtual VS real world. The geometric approach was inspired by "William Forsythe's Improvisation Technologies and beyond" (Ziegler, 2016), this approach presents a simple and

geometric structure. The dancer's body draws straight shapes in space that show how the dancer creates his personal space while performing. In this approach, dance is a practice of geometric inscription, in which geometry is inscribed, or often using the inscription of geometry to create an effect. The different approaches are in the constant connection between the dancers' bodies and express the relationship between each body part during the dance performance within the space. However, the present connections are only a selection from a large set of experiments performed, and that represents the main concept of this work. There are countless possibilities of connections between the different *keypoints*, and these possibilities can be explored by any participant.

Conclusion

The visual dialogue through “*FORMS*” gives a new movement perspective in which the dancer and the audience have a new layer that provides body awareness and gives the audience a clearer understanding of the dancer's spatial occupation, but also of the body effort itself. Given the importance of our role as researchers in areas such as art and technology, it is our mission to democratize these areas and bring the most different audiences closer to these research fields. For this reason, we intend to turn the development of the proposed technology into an interactive installation, in which the spectator can enjoy a performance, but afterward can be the dancer himself and get involved with his movement and installation. The results of the exhibition verify the effectiveness of the proposed work, likewise, this art practice proves that the involvement of technology in art gives rise to new creative approaches, facilitates the process of learning and understanding movement, and contributes to bringing the audience closer to dance.

Acknowledgments

We thank our colleagues from the Institute of Systems and Robotics, and the College of Arts, both institutions from the University of Coimbra, Portugal. We thank the Dance N'Arts School of Coimbra for providing space for the research of movement studies. We thank gratefully acknowledge the financial support of “Fundação para a Ciência e Tecnologia” (FCT – Portugal), through the Research Grant (2020/09137/BD) at the University of Coimbra, Portugal.

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