

Analyzing the Role of the Data behind Interactive Installation Works

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Abstract:

With the development of science and technology and the improvement of people's living standards, interactive installation art has gradually become a bridge connecting the artist, the work, and the audience, making the art experience more diversified, special, and in-depth. This paper first identifies that there are different sources of data behind different interactive installations, including natural data, experimental data, and creative data. Subsequently, it is found that these different sources of data provide different forms of movement, mainly active movement, passive movement, and expressive movement, and it is these movements that give the works vitality and interactivity. Finally, it is analyzed and found that different data works have shaped different themes of the works, which can be summarized as humanities and social sciences, science and technology, and business. In conclusion, we hope that by analyzing the visual appearance of the interactive installations, we can explore and discover the logic and codes behind them and provide new perspectives and inspirations for their creation.

Keywords:

Interactive Installations, Interactivity, Data, Movement

1. Introduction

With the development of the economy and technology, people have gradually shifted from being passive audiences to active participants in art creation. [1] Interactive devices have become an important medium for communication between art and the audience, allowing real-time interaction with the artwork and facilitating in-depth communication and exchange. The core of this transformation lies in the data behind the scenes. The source of the data sets the direction for the work, while the processing and transformation of the data affect its interactivity and immersion. The visualization and thematic expression of data are crucial in determining the work's concept, and through artistic processing of the data, the work can be made more intuitive and visually appealing. In this paper, we will explore the multiple roles and functions of data in interactive installations, as well as the potential impact, value, and prospects for the innovation of artwork by analyzing the data sources, applications, and expressions of different interactive installation works.

2. Installation Art

2.1. Definition and Development of Installation Art

William C. Seitz once defined installation art as follows: “a. It is primarily assembled, not painted, traced, modeled, or sculpted. b. All or some of its constituent elements are preformed. c. Natural and artificial materials, objects, or fragments are not intended to be used as art materials.” [2] This statement highlights the qualities of installation art as an entirely new art form. “Installations are not viewed from a distance but require the viewer to be fully immersed in the work, engaging in a wide range of experiences and perspectives, interacting with the system and others, and enabling people to join in.” [3] This emphasizes the nature of installation art as a new art form. Installation art aims to create an immersive experience by “including” the viewer in the work, interacting with them in a specific time and space, and allowing them to perceive from multiple perspectives, to connect with the system and others, and finally to become a part of the work, thus forming a unique art experience. In short, it is public art characterized by the integrated presentation of “site + material + emotion.” [4]

The origins of installation art can be traced back to the 1960s, with its forms and concepts stemming from Dadaism and Surrealism. Dadaism challenged traditional art concepts and had a rebellious spirit, providing a philosophical basis for developing installation art. Subsequently, the Russian Constructivists proposed the idea of combining art with everyday life and created works called “spatial constructions,” which are considered one of the early forms of installation art. Surrealist environmental art provided a direct precursor to installation art by integrating the viewer's experience of space and immersion. From the 1960s through the 1970s, installation art began to make extensive use of light, sound, video, and various ready-mades to create works that required audience participation and interaction.

Installations have also continued to incorporate emerging technologies. For example, the Internet of Things (IoT) technology, whereby sensors and other devices are embedded in installations, allows artists to realize real-time interaction and feedback between the work, the viewer, and the environment. Some installations utilize IoT technology to realize various sensing elements such as touch, sound, and light, enabling the audience to change the form and state of the work through interaction, thus participating in the art creation process.

2.2. Interactive Installation Art

What is interactive installation art? The concept of interaction comes from the Latin words “inter-” (meaning “between”) and “agree” (meaning “action”). In a broad sense, “interaction” refers to any form of two-way action or communication involving the exchange and mutual influence between two or more objects or individuals. The key element of interaction is two-way or multi-directional participation and response, which can be on a physical, virtual, emotional, or cognitive level. In the case of interactive installations, “art becomes interactive when the behavior of the viewer becomes an integral part of the artwork.” [5]

Interactivity characterizes interactive installations, and immersion is the goal. In interactive installations, the viewer is no longer a passive recipient of the work but becomes part of the creativity and performance, suggesting that interactive installation works emphasize interactivity, which is often thought to enhance the attractiveness of

the experience, making it more interesting and memorable for the viewer. “Immersion is a specific phenomenon in human mental ecology, characterized by the person's focusing of attention on a certain realm or thought activity.” [6] When we look for such characteristics in interactive installations, we find that they often try to create an experience or perception of a “virtual world” for the audience, and make changes according to human behavior, i.e., to immerse the audience in human perceptual and sensory aspects. [7] In general, the higher the audience's participation, the stronger the experience, and the more feedback given to the work and the creator, i.e., interactive installation art creates immersive experiences, including the audience in the work, and forming a unique art experience.

3. The Data of the Works

In contemporary interactive installation works, the application of data provides key support for the realization of interactivity and immersion. Properly utilized and transformed by data, interactive installations not only create compelling artworks but also inspire emotional resonance in the viewer, thus enhancing the quantity, quality, and depth of the art experience. Data provides dynamic support for interactive installations, while precise design and feedback mechanisms strengthen the connection between the work and the audience.

3.1. The Source of the Data

Data is the foundation of interactive installations and is categorized into three main types according to its source: natural data, experimental data, and creation-generated data. These three sometimes stand alone, and sometimes are interconnected; natural data might be obtained through experiments, experimental data might originate from nature, while creation-generated data is the necessary link for them to become artworks.

3.1.1. Natural Data

Natural data refers to data derived from nature, such as changes in plants (growth cycles, changes in leaf color, blooming and wilting of flowers), changes in animals (activity patterns, migration paths, population fluctuations), weather changes (temperature, humidity, wind speed), stellar changes (planetary motion, star brightness, and other astronomical observations), crustal movement changes (seismic activity, surface morphology changes, rock composition), and geographic features (topography, land use, water distribution).

Natural data is widely used in interactive installation art, with authors employing technical means to process these data for dynamic or static interaction, making the work's scene more realistic, vivid, and emotionally resonant. For instance, in the work “Streaming Stillness” (Figure 1), the author draws inspiration from the topographic changes in the Helan Mountains, connects real change data to artificial intelligence, and through deep learning of Chinese ink paintings across the ages, presents an effect between the surreal dimension and the virtual field using projection methods. The ever-changing natural landscape prompts the audience to reflect on the relationship between humans and nature. The application of natural data can effectively convey environmental themes and enhance the audience's experience and empathy. By artistically processing natural data, authors can create works that are both visually appealing and thought-provoking, encouraging the audience to deeply consider the relationship between humans and nature during the interaction process.

3.1.2. Experimental Data

Experimental data, derived from scientific experiments across various fields such as physics, chemistry, biology, and psychology, provides rich material and inspiration for creation. It is collected, analyzed, processed, and transformed to be re-designed into works.

The scientific nature of experimental data offers a strong reference for artistic creation. For instance, the installation “Cedar Point Reeds” (Figure 2) is designed in real-time based on the real-time wind speed data from the wind farm. The luminous brightness of the 400 acrylic-made reeds indicates the power generation capacity. As the audience passes by, the acrylic “reeds” simulate real dynamics, changing their tipping direction to follow the winds brought up by the audience. This work artistically presents the scientific principles of wind power generation through an experimental data-driven approach, not only showcasing the principles to the public but also raising awareness of renewable energy. Experimental data can create scientific interactions, such as presenting different images and sound effects based on the audience’s actions, through sensing technology and computer algorithms. This brings a richer and more personalized artistic experience. The artistic expression of experimental data can make scientific theories and research results more enjoyable and inspiring, promoting the audience’s understanding of scientific principles and research progress while enjoying art. The reasonable use of experimental data can create works that are both ornamental and scientific, enhancing the audience's artistic experience and scientific knowledge.

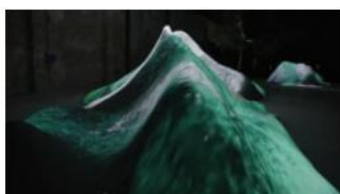


Figure 1. *Streaming Stillness*, interactive installation, 2020.



Figure 2. *Cedar Point Reeds*, interactive installation, 2022.

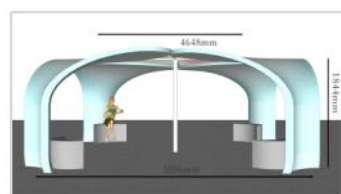


Figure 3. *Four Leaf Clover*, installation, team, 2024.

3.1.3. Creation Data

Creation data refers to all kinds of data generated during the design and creation process, including not only the design data of the work but also audience interaction data, such as shape, color, size, audience behavior, feedback, and interaction. Creation data can reflect the dynamic changes in the work and the way audience participation occurs, which is an important basis for understanding and optimizing interactive installation art.

Creation data is both an essential medium for art creation and a key factor in enhancing the audience experience and the interactivity of the artwork. For example, in the work “Four Leaf Clover” (Figure 3), the shape, color, size, and other data recorded by the author during the design process constitute the basic framework and visual elements of the work. The creation and analysis of this data not only reveal the sensibility and warmth of the work but also demonstrate the author's in-depth understanding and exploration of the art creation process. By recording and analyzing the data, the author can deeply analyze the expression and interaction of the work and make adjustments and optimizations. Through the rational use of creation data, the

author can continuously improve and innovate the interactive installation, making it more attractive and interactive.



Figure 4. *Descension, interactive installation, 2017.*



Figure 5. *Van Gogh Path, smart highway, 2012.*



Figure 6. *Beauty In Complexity, interactive installation, 2021.*

3.2. The role of Data

Behind every vivid and imaginative interactive installation work lies a set of running logic, namely, the movement brought about by data. There are three main forms of motion: Active motion, sensing motion, and expressive motion. Different forms of motion create different interactive effects, thereby enhancing the audience's experience and immersion.

3.2.1. Active Movement

Active movement refers to the device's movement under a preset data trajectory without external trigger intervention. It enables the interactive device to interact with the audience more naturally and smoothly, driven by internal data, with spontaneous performance, free from external interference, and capable of adjusting and changing in real-time according to the internal data.

Active movement provides an immersive viewing experience for the audience. For example, the work "Descension" (Figure 4) fully demonstrates the characteristics of data-driven movement, where the pool is a constantly rotating water flow. The surging water keeps swirling and circulating as if bringing the audience into this torrent, serving as a metaphor for mankind's endless exploration of the mysteries of nature. This spontaneous movement reflects the autonomy and data-driven nature of the installation.

3.2.2. Passive Movement

Passive movement is the core mechanism in interactive installations. This type of motion triggers the device's response by sensing external changes in the viewer's movement, touch, sound, or temperature. In passive movements, data can provide various movement modes, or interactive modes, on the one hand, and the other hand, it collects the user's movement data to provide feedback on the effectiveness of the interaction.

Passive movement establishes a two-way communication channel between the viewer and the work, forming a dynamic interactive cycle that not only enhances the viewer's sense of participation but also makes each interactive experience unique. For example, in "Cedar Point Reeds" (Figure 2), the dynamic changes in the acrylic "reeds" are realized by sensing the viewer's movements. The data-driven passive movement can provide a more unique experience for the audience, and the variability of the external environment also provides the art installation with rich forms of

expression and possibilities, while opening the possibility for the author to explore new forms of human-computer interaction.

3.2.3. Expressive Movement

Expressive movement refers to the concept and process of conveying motion through data while the interactive installation remains static. Authors collect data and use algorithms or programming to transform this data into dynamic visual effects in virtual environments (e.g., VR) or superimpose virtual elements into the real world (e.g., AR), and this approach is widely used in holographic projections and certain games.

Expressive movement enables static installations to display dynamic performances beyond physical limitations, bringing a new visual experience to the audience. For example, the work “Streaming Stillness” (Figure 1) utilizes artificial intelligence technology to transform realistic terrain changes into dynamic visual effects, which can display ever-changing terrain on a static body block. This data-driven dynamic visual experience will enable viewers to feel the changes in motion within a static work, thus enhancing their understanding and perception of the work. Expressive movement does not involve real physical movement but rather uses technical means to convert static data or images into dynamic visual images, providing a surreal artistic experience that stimulates the audience's senses.

3.3. Discerning the Theme of the Work

The theme of interactive installations spans a wide range of fields, such as humanities and social sciences, science and technology, and business and finance. The use of data in interactive installations not only provides a dynamic form of movement for the work but also plays a role in expressing the work's theme. Different data types can be redesigned to present a rich variety of themes.

3.3.1. About Humanities and Social Sciences

In interactive installations themed around the humanities and social sciences, data becomes a bridge connecting individual experiences with collective consciousness. Through these installations, creators can guide the audience to participate in discussions and express their concerns about social phenomena and cultural issues. This not only showcases the author's expression but also prompts the audience to explore and think, ultimately strengthening the communication and interaction between the author, the work, and the audience. The work “Four Leaf Clover” (Figure 3) primarily creates a natural and environmentally friendly interactive installation space that expresses care for human beings and human nature. The work uses solar energy to provide electricity, sense temperature changes and present different color appearances. Through temperature-sensitive materials, it presents a light pink color when below 5°C, light yellow from 5°C to 15°C, white from 15°C to 20°C, and light blue above 20°C. In this semi-enclosed space, people can interact, communicate, and rest, and they can also look up at the sky or nebulae, which helps facilitate human interaction and relieve stress and anxiety in the room.

3.3.2. About Science and Technology

In addition to the humanities and social sciences, data plays a key role in interactive installations themed around science and technology. In recent years, with the

integration of aesthetics and technology (aestheticization of technology and aestheticization of technology) [8], interactive installations are perfectly combined to create works of art that spread scientific and technological knowledge and demonstrate new technologies. For example, the work “Van Gogh Path” (Figure 5) is a path composed of 50,000 glittering stones, in which environmental data (such as light intensity, vehicle passage, etc.) are collected and processed in real-time to drive the luminous effect of the stones on the road. This data-driven interaction not only demonstrates the beauty of technology but also improves nighttime driving safety through real-time data processing.

3.3.3. About Business and Economy

Due to their unique interactivity and immersion, interactive installations have become an effective tool in the commercial sector to enhance customer experience and improve brand image, not only improving customer experience but also directly promoting sales. Some brands have integrated interactive installations into their branding and space design, such as the artwork “Beauty In Complexity” (Figure 6), which successfully showcases BMW's latest programming technology and conveys BMW's vision of digital development. Interactive installations can boost foot traffic and brand impact, providing visitors with a memorable experience. With the advancement of technology, the application of interactive installations in the commercial sector is promising. In the commercial and financial sectors, data from interactive devices, including customer interaction data, traffic flow, dwell time, and interaction frequency, can help merchants conduct market analysis and optimize product layout and marketing strategies to increase sales. After in-depth data mining, merchants can more accurately understand customer needs, improve operational efficiency, and realize higher business returns.

4. Conclusions

From the collection of natural data to experimental data, and the data generated by creation, this paper shows how data shapes the active, passive, and expressive movements of the work to realize the expression of different themes, including the exploration of humanities and social sciences, the demonstration of science and technology, and the application of business and economy, all of which demonstrate the importance of status and role of data in the work.

Nowadays, with the development of big data and artificial intelligence technology, the collection, analysis, and application of data will become more intelligent and precise. These technological advances and changes are quietly affecting the innovation and expression of interactive installation works. The introduction of data enables authors to dig out interesting stories and magical phenomena from massive information, injecting new vitality into artworks. Through the visualization and interactivity of data, complex information will be transformed into intuitive visual elements, making the works visually perceptive or sensory-sensitive. They can be used as educational or healing tools to promote social dialogue and cultural dissemination, influence the audience's emotional response, and thus enhance the communication and interaction between the author, the work, and the audience.

It is believed that in the future, interactive installation works will become more diversified, widely promoting the development of culture, education, business, and the environment, and promoting social progress and civilization. Only by deeply

understanding and mastering the “code” of data can we create more artworks that meet the development of this era, better understand, and express this world, and contribute to the development of human spiritual civilization.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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