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An Exploration of the Artistic Design of Integrated Material Fusion Installation Based on Sound Interaction

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Abstract. This research is dedicated to addressing the shortcomings of garbage recycling devices in public places in daily life, enhancing people's concept of environmental protection and integrating the expression of installation art. It empowers public spaces by adopting a mixed-material installation art fusion design based on sound interaction. In the project, the participants' action of throwing garbage is artistically extended and combined with the installation art design to create a human-computer interaction installation art design application mode of integrated material fusion with sound visualization. The goal of this design is to stimulate the interaction between the participants and the recycling device, so as to stimulate their awareness of environmental protection, and to realize the fusion of science, technology, art and humanities in the art design, so as to inject new vitality into the public space. The project is based on the design concepts and theories of contemporary art, and at the same time integrates the knowledge of computer graphics, integrated materials, installation art, public art and other fields, and carries out the integrated design of integrated material installation art with sound interaction as the core. This design concept was proposed with the aim of promoting environmental awareness and realizing art fusion by introducing art elements and stimulating participants' interaction. In the design of the installation, the sound generated by people throwing objects is collected by installing microphones inside the installation, and the sound data is converted into floating point values, which are written and calculated by the multimedia interactive software code, triggering two interactive behaviors: firstly, the sound data is converted into a visualization effect with image forms, and secondly, the collected sound data simultaneously triggers the audio feedback synthesized by the computer, which is outputted through the loudspeaker, finally presenting the sound and the image in the viewport. Eventually, the artistic graphics of sound and graphic interaction are presented in the viewport, realizing an installation art that integrates synthesized materials and sound visualization. In the practical phase of the project, the field research method was used to interview the participants, and the results showed that the participants showed a high degree of acceptance of the concepts conveyed in this project. This shows that through the interaction with the installation, people have thought deeply about the relationship between the concept of environmental protection and the aesthetics of art. The whole study emphasizes the potential of innovative design to trigger human-computer interaction in public space, which not only solves the practical problem of waste management, but also promotes a comprehensive understanding of environmental protection and art in society.

Keywords. Synthesized materials, Sound interaction, Installation art, Fusion design

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1. Introduction

This project is dedicated to solving the problem that traditional methods of garbage recycling fail to enhance people's enthusiasm for participation. Through the fusion of integrated materials and sound visualization, the project aims to cultivate environmental protection concepts and enhance artistic aesthetics in the form of installation art. We recognize the limitations of public waste recycling installations in terms of artistic expression, focusing only on sorting and disposal but neglecting perception and interaction. Therefore, the solution not only focuses on improving the management of recyclable materials, but also on how to stimulate people's concern for the environment through installation art and sound visualization.

The project utilizes contemporary art design concepts that integrate technology, art and humanity. The sound data generated by the thrown objects is collected through an internal microphone, processed and transformed into a visualization using Processing code, and computer-synthesized to create the sound effect of falling stones. This innovative approach transforms trash throwing into artistic expression, creating a unique interactive experience that realizes the goal of human-computer interaction. The results of the field observations show that the integrated material installation art is attractive, conveys the spirit of environmental protection, renews the way of artistic creation, and is sustainable in terms of materials, and plays a role in enhancing the awareness of environmental protection and the participants' artistic aesthetics.

In conclusion, this project not only provides a novel approach to waste management, but also demonstrates practical examples in the interactive integration of technology, art and humanity. Through the combination of creativity and technology, it injects more innovative and artistic elements into the public environment, promotes the dissemination of environmental protection concepts, and provides new ideas for sustainable development. The replicability and scalability of this approach provides valuable insights for innovation in other fields.

2. Contexts

2.1. Sound Installation

While most sound installation art has been exhibited in indoor venues, artists have gone outdoors to exhibit their work, utilizing the variability, unpredictability, sonic complexity, and dynamism of the environment to create their work. Many of the pioneers of sound installation art exhibited their work in outdoor venues, including Max Neuhaus's LISTEN: Field Trips Thul Found Sound Environment (1966), which stamped the word "LISTEN" on the hands of participants and then led them through the process of creating a sound installation. as in Figure 1, and then led them on a silent sound walk through urban locations at night[1].The mechatronic creations of Godfried-Willem Raes and Trimpin both independently utilize mobile design principles, as many of their creations include casters that allow for easy transportation of musical instruments between performance venues[2]. Raes's writings suggest that some instruments, such as the Toetkuip (1987), Klankboot (1987) and Le Grand Coucou (1997) were explicitly conceptualized and Le Grand Coucou (1997) was explicitly conceptualized and constructed for use in outdoor exhibitions, with design features that supported mobile exhibitions, including a power system based on lead-acid batteries.

However, the mobility of these objects is limited by the fact that Toetkup and Klankboot weigh 180 kg and 240 kg, while their electronic systems are exposed to environmental conditions. Our research addresses these transportability constraints by using environmentally friendly electronic enclosures to allow for exhibitions in harsh weather conditions, and prioritizing the transportability and size of the objects to ensure that waste put-in and waste take-out can be carried out safely and conveniently.

Figure 1. Max Neuhaus "LISTEN"

Source: https://www.cafamuseum.org/exhibit/newsdetail/2461?ivk_sa=1024320u

Since the good transportability of installation art provides ample opportunity to study installations for environmental protection roles, research will include the realization of installations that utilize multiple sound devices. However, fieldwork must be adapted to people's level of engagement, which limits our ability to collect subjective assessment data from the public. Therefore, research practice work includes evaluating the effectiveness of different levels of sound on image visualization enhancement strategies.

2.2. Comprehensive material creation methods and application fields for the beautification needs of public environments

Comprehensive materials and media are the product of modern art change, it is from the aesthetic concept, way, medium and technique are closely around the change of tradition, and then express the modern people's views on the art process, modern life, is to understand, contact and study the window of modern and contemporary art [3]. The combination of plane and space, installation, art design and computer science, through the integration of different fields of design, the expression of integrated material art is more and more diversified, and the visual effects presented are more complex and diverse. With the help of integrated material installation art to interpret environmental issues to the audience, so that the participants with the public space to form an interaction, not only enriches the formal appearance of the art, but also greatly enhance the expressive power of art and art of the human spirit [4]. The theme presented by integrated material art is no longer a simple beautification of space, but can convey people's voices and attitudes towards an event, integrating the concepts of "site, material, and emotion", and enriching people's enjoyment of the public space environment [5]. Comprehensive material installation art uses computer hardware and software to form a three-dimensional space through the medium of the installation, introducing the participants into the creative environment, and participating in the creation of the artwork through the participants' sense of hearing, vision, and touch.

This project explores the design principles, design elements and design applications of digital media interactive integrated material installation art design based

on environmental protection. This project explores the relationship between integrated material art and human environment from the perspective of artistic intervention in public space. Through the observation, investigation and case study of comprehensive material art, it elaborates the intervention strategy and characteristics of comprehensive material installation art in public environment, analyzes the role of comprehensive material installation art in public space of human habitat, and finally summarizes the value of comprehensive material installation art to human habitat environment.

3. Design process

3.1. Mechanism of the relationship between the openness of synthesized materials and the publicity of public art

Openness of Materials and Creativity in Art: The openness of mixed materials allows artists to be more innovative in their designs and creations. These materials are usually composed of many different elements, including but not limited to metal, plastic, fiber, etc. Artists can give full play to their creativity and break the boundaries of traditional art to create unique, durable and expressive works.

The public nature and interaction of public installation art: public installation art emphasizes interaction and participation with the audience. Compared with traditional art museums, the audience is more accessible and involved. By using a combination of materials, artists can create more interactive public installations. For example, some works may contain sensors, photovoltaic elements, or other technological elements to increase audience interaction and interest.

Sustainability and Environmental Protection: By choosing recyclable materials or designs that extend the life of materials, artists can create more environmentally conscious works in public spaces. This sustainable design is in line with the goal of public installation art, which is to convey the message of social, environmental and sustainable development through art, and to deepen people's impression and perception of environmental behavior.

Social participation and sharing culture: The openness of mixed materials helps to create works that can trigger social participation and sharing culture. This participatory and shared nature makes public installation art a medium that connects people and promotes socialization, while also creating a unique identity for the community.

The "public art event" formed by the intervention of mixed-materials installation art in public space not only attracts the attention of the media, artists and the public, but also creates public opinion. The combination of installation art, multimedia and high technology creates some interesting interactive experiences in the space. The novel interaction changes the traditional way of experiencing space and breaks the previous way of public participation in public life [6].

3.2. Design for integration

Expanding new ways of sorting and collecting recyclable waste: a sound-visualization interaction guides the participants to put the waste into the corresponding collection location at the time of the drop-off. The installation feeds back unique sound effects and presents visual images, transforming trash drop-off into an artistic act. This

collective activity culminates in a mixed-media artwork that turns recyclable waste drop-off into a creative performance art.

Create a new visual experience: This innovation not only brings a sense of novelty in the visual effect, but also forms an impactful spatial vision. Breaking through the boundaries of the original public space landscape design, this creative design enables people to go beyond the traditional behavioral cognition, injecting a more attractive way of classifying and recycling garbage, and providing participants with a rich emotional, visual and aesthetic experience.

Formation of a new interactive environment: "Integrated material fusion sound visualization installation" changes the traditional way of art creation, and with the support of digital technology, it can better attract the public to participate in the interaction. The public is no longer just a spectator, they need to be actively involved in the interaction to make the artwork meaningful and complete, and the role of the public changes from viewer to designer or creator.

Creating public art activities: When the mixed-material installation art based on sound interaction appears as a kind of public art in the public space of human habitation, it will firstly arouse people's curiosity and then participate in it. The public's participation and attention to art intervention in environmental protection activities form a public art event that attracts the attention of the art world and society, and makes people think about the deeper meaning behind the works. This is also the positive significance of the mixed-material fusion installation art based on sound interaction to intervene in the public space of human habitation.

4. An Exploration of Model Building Practices

4.1. Using Processing to call Minim Library for sound visualization

For this practicum, we implemented real-time visualization of sound using Processing software, a Java open-source integrated development environment built for new media art, visual design, and electronic art. It is designed to allow artists to programmatically design computer images using code, providing an innovative way to explore the intersection of visual art and technology. Before using Processing to write code, you need to pre-install a third-party library, Minim Library, which is used to realize the microphone data of the computer through software calls, and realize the microphone to transfer the collected data to Processing. Minim Library is a program for audio processing and audio data analysis, which provides developers with a set of tools and The Minim Library is a program for audio processing and audio data analysis that provides developers with a set of tools and functions that make it easier to process and manipulate audio in Processing. It combines audio file loading and playback, real-time audio analysis, audio effect processing and recording, and allows users to re-edit audio through function code, helping users to process audio data and enhance sound visualization in Processing. Through the use of Processing, we are able to transform the sound collected by the microphone into computer-recognizable data and generate images, thus realizing the real-time interaction between sound and image in the art design of the integrated material fusion installation based on sound interaction in this project.

After running the code, we can see a visual image of the sound data in the Processing demo window. This is obtained by converting the sound amplitude

collected by the microphone into floating point data and running it through the code. The stroke color of the graph can be changed by adjusting the value within the stroke in the code. Also, different forms of sound visualization images can be generated by changing the way the floating-point values are calculated in the code, as shown in Figure 2.

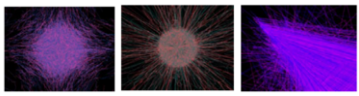

Figure 2. Visualization images of different manifestations of sound

4.2. Combining multimedia projection equipment to realize multi-dimensional sensory experience

The art design of the integrated material fusion installation based on sound interaction will create an art experience that combines sound, material and visual elements. The installation converts the sound data generated by the participants' throwing objects into floating point values by installing microphones, and through Processing code writing and calculation, these sound data are transformed into visualizations with image forms. These images were re-edited and exported in Madmapper, a multimedia projection design software, to create a fusion of synthesized material and sound visualization. As shown in Figure 3, in this process, we connected the participant and the installation through real-time interaction. When a participant throws an object, the installation's radio equipment captures the sound data and converts it into a visualization, while playing the sound effect of a falling stone through an external speaker. These effects are displayed on the transparent window plane of the installation, interacting with the participant's interactive behavior in real time. This interaction presents a dynamically changing art experience, allowing people, sound and installation to reach an effective real-time interactive closed loop.

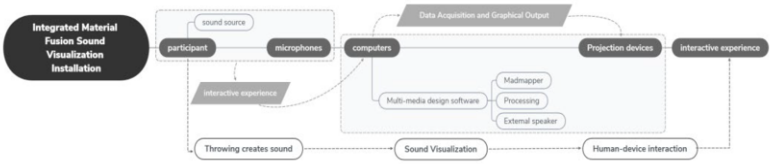

Figure 3. Operational flow of the integrated material fusion sound visualization device

4.3. Practice and summary

Fieldwork, structured observation, and structured interviews were used to gain a comprehensive understanding of the acceptance of the device by the pedestrians who participated in the study. To ensure the objectivity and comparability of the data, we prepared a set of standardized questions focusing on three aspects: behavioral

observation, interaction process, and interview feedback before the structured interviews. These questions were the same or similar from one interviewee to the next, allowing us to more effectively compare responses across interviewees. During the interview process, we not only focused on the respondents' direct answers, but also obtained richer information by pursuing in-depth questions and observing behavioral details. This helped to dig deeper into the interviewees' perceptions and feelings about the device, leading to a more comprehensive understanding of their attitudes and perceptions.

Finally, in order to provide a comprehensive and systematic summary of the data obtained, we adopted a comprehensive generalization approach [7]. By integrating the various observations and interview responses, we formed an overall understanding of pedestrians' recognition of the device. This comprehensive summarization allowed us to gain a deep understanding of the findings and provide a strong basis for future research or improvement. The multilevel and multifaceted approach adopted in this study resulted in a more comprehensive and in-depth study of pedestrian recognition of devices, and more reliable and convincing data.

4.3.1 Practice Location

This installation requires the use of public space. The solution to the problem of using public space on campus for these installations is to first contact the institution that manages the public space on campus and explain to it the reason for using the public space, and then to request the use of the public space from the university administration and obtain its consent for the use of the space in a reasonable manner in order to avoid any ethical issues arising from the research.

The study was conducted in Zhongkai Agricultural Engineering College located in Haizhu District, Guangzhou City, Guangdong Province, China, and the device model was placed on the first floor of Building A of the student dormitory of the Haizhu Campus of Zhongkai Agricultural Engineering College, the exact location can be seen in Figure 4. The practice site is surrounded by buildings, sports fields and greenery, and the buildings are mainly functioned as the student dormitory. There are five passages around the practice, and students can see the installation model from different angles. This is the location where the public trash cans were originally placed, providing students with a daily role in putting out trash. The installation does not change the students' living habits and the use of public facilities, but it is innovative in form and artistic expression. In the process of putting out the garbage, students subconsciously developed the concept of garbage classification and promoted their environmental awareness.

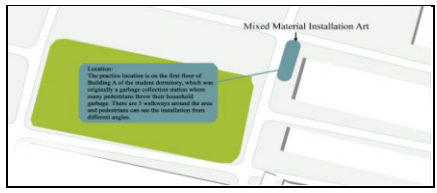

Figure 4. Installation practice locations

4.3.2 Field observations

During the seven-day data collection exercise, the author kept detailed records of the 530 people observed in the study, paying special attention to their recognition of their interactions with the device. In this, ten pedestrians were interviewed through random interviews, two of which were observed as follows:

The first interviewer was a male, freshman, at 12:35 p.m. on a Tuesday: Behavioral observations indicated that the student had just finished lunch and was preparing to return to his dormitory for a break. As he passed under the dormitory building, he noticed the device and his demeanor showed mild confusion. However, he was still willing to participate in the interaction. During the interaction, the author found him holding a bottle that he was about to finish, which he cleaned and put into the device with the "plastic" logo. At this point, the device emitted a sound effect of a falling stone through an external speaker and displayed a real-time visualization of the sound. Feedback from the interview showed that the student said he was surprised by the creative installation. He felt that he was not participating in littering, but in an artistic endeavor, and was very receptive to the installation.

The second interviewer was a female, third year graduate student, at 9:15 a.m. on a Saturday morning: Behavioral observations revealed that the student was preparing to go out for a part-time job and stumbled upon the device on the way. She showed a preference for novelty and was excited to participate in the interaction. During the interaction, she threw a candy wrapper from her bag into the device. Staff then conducted an interview. Feedback from the interviews indicated that the student stated that she likes to try new things and was excited to see this novelty-filled installation. She thought it was interesting and necessary to install similar installations in public areas of the campus because of the school's high level of student activity and curiosity. She is looking forward to seeing the finished product of the subsequent mixed-media work and recognizes the installation.

4.3.3 Observational discussions

From a social research perspective, it can be observed that the creativity of the installations elicited the active participation of the students, whose feedback indicated that such public installation art was popular on campus and stimulated students' interest in art creation while provoking them to think about environmental protection. This field observation also provided, for the topic of designing an integrated material fusion installation art based on sound interaction, useful insights into the social impact and interaction of installation art in the campus environment, which can be categorized into the following five points:

1.Social participation and interactive effects: Through observation and interviews with pedestrians, we can see that the installation successfully triggered active participation and interaction among students. This reflects the potential of public installation art to break down the traditional barrier between audience and art, prompting people to participate in the creation of art. It also reflects the need for interactivity and participation in society.

2.Creativity and recognition: Observations showed that students highly recognized the creativity and uniqueness of the installation. In particular, the first visitor viewed the installation as an artistic creation rather than just a trash can. This reflects the importance of innovative design in enhancing the recognition of public art and people's openness to art.

3.Consideration of the characteristics of the student body: Through the interviews mentioned above, we learned that the school's students are highly active and curious. This suggests a rationale for installing similar installations on campus, as the student

body is more willing to accept and participate in innovative art forms. This is crucial for the promotion and acceptance of public installation art in a given community.

4.Socio-cultural and art appreciation perceptions: Feedback from visitors indicated a willingness to accept and expect to see more similar installations in public areas. This reflects the contemporary society's appreciation of diversity and novelty in art. Public installation art helps to broaden people's perception of art forms and promote social and cultural development.

5.Expectations for follow-up works and social impact: During the interviews, some participants expressed their expectations for follow-up mixed-material works, which reflects people's continued interest in and expectations for art projects. This also implies that successful public installation art can generate good reputation and influence in the society, providing a positive social environment for future art projects.

4.4. Summary of the chapter

During the authors' observation period, the observation population encompassed undergraduate students, graduate students, faculty, staff, family members of faculty and other school personnel. 78% of pedestrians were willing to use the device for interaction, and 67% of the observation population was male and 33% was female. The observation population consisted primarily of undergraduate students, graduate students, faculty, staff, family members of faculty and other school staff. The 10 people interviewed rated their approval of the device, with 1 being disapproved, 5 being highly approved, and the average value of the 10 people was 4.5, with the specific satisfaction value shown in Figure 5, which shows a high level of approval of the device. Overall, the observations show that pedestrians have a high level of approval of the installation, especially in terms of environmental protection and artistic aesthetics.

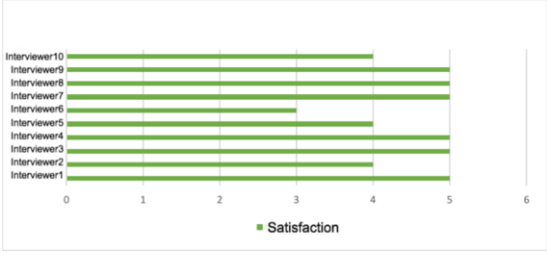

Figure 5. Interviewer recognition of device

The art design of this Integrated Material Fusion Sound Visualization Installation aims to integrate sound visualization technology with the elements of integrated material art creation, inviting participants to interact with the installation to create a unique and meaningful artwork, as shown in Figure 6. Through the integrated material fusion sound visualization installation, we can explore the relationship between sound, material and visual elements to construct a new art experience. In addition, the outer body of the installation is made of an environmentally friendly electronic casing, following the principle of circular economy, using fiberglass-reinforced plastic as well as acrylic, which ensures the translucency of the installation and at the same time facilitates the handling of the installation.

Figure 6. Model of integrated material fusion sound visualization device

Considering that the materials of this installation art will have aging problems with time in the process of using, there will be certain safety hazards, and may even have a bad impact on the environment, so this in the design of this comprehensive material installation art with the function of garbage recycling, will use the appearance of the materials that can be disassembled and replaced, regularly check the function and materials of this installation art, and iteratively update the unapplicable parts and materials, and continue to transcend the old design works, and continue to enhance the safety, interactivity, and artistry of the cover.

5. Conclusions

Installation art has gradually shifted from indoor to outdoor public space, influenced by technological progress, creating unprecedented visual impact. Installation art in public space is closely related to the improvement of science and technology and urbanization level, reflecting the public's aesthetic and cognitive improvement of art. This project takes sound interaction-based integrated material installation art as a form of public art, uses computer interactive visualization technology, combines art and programming to create richer visual works, intervenes in public space with integrated material installation art as a form of public art, takes the interaction between the installation and people as a start, and applies computer interactive visualization technology to allow the artist to collect the required data and information in any environment, and puts artistic philosophies into practice. Using computer interactive visualization technology, the artist can collect the required data in any environment, integrate the artistic philosophy into the programming code, and present visual art works with richer artistic context through computer language.

Due to the limitations of equipment and technology, the study fails to fully demonstrate the artistic thinking and visual expressions in the design of sound visualization installations. There is a problem of singularity in the presented sound visualization patterning. In the future research, the author will also be committed to fully utilizing the potential of computer language, which will, I believe, bring more innovation and progress to the subsequent works of integrated material installation. Through sustained efforts and the continuous development of science and technology, subsequent research can fully demonstrate the artistic appeal of sound visualization installations, presenting audiences with a richer and more profound perceptual experience. This effort will not only enhance the artistic expression of the mixed-materials and sound visualization, but also improve the overall artistry.

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References

[1] Max Neuhaus, “Sound Art”in Volume: *Bed of SoundNew York: P.S.1,* 2000.
[2] Raes, Godfried-Willem. Music and technology on the threshold of the twenty-first century. *Full citation.* 1988.
[3] M. Xiaoxiang ,“Discussion on the media application, media communication and artistic language of new media installation art”(in Chinese), *Aesthetics Art Res., no. 4, pp*. 153–155, 2019.
[4] Petrelli D, Ciolfi L, Van Dijk D, et al. Integrating material and digital: a new way for cultural heritage. *interactions*, 2013, 20(4): 58-63.
[5] Kim D, Boradkar P. Proceedings of the IDSA National Design Education Conference. *Sensibility Design.* 2002: 17-20.
[6] L. Huiyu, “Analysis of the relationship between installation art, the masses and the city in contemporary times” (in Chinese), *Mingrifengshang,* no. 12, pp. 184–185, 2020.
[7] Feng Xiaotian. Social Research Methods. *Beijing: China Renmin University Press*, 2018.4.