EAI Endorsed Transactions
on Scalable Information Systems
Research Article EAI.EU

Smart Painting Exhibitions: Utilizing Internet of Things Technology Creating Interactive Art Spaces

Xiaoyan Peng and Chuang Chen*

School of Art and Design Zhengzhou University of Industrial Technology, Zhengzhou 451100, Henan, China

Abstract

INTRODUCTION: With the rapid development of science and technology, intelligent painting exhibitions have gradually attracted people's attention with their unique forms. This study aims to create an interactive art space using Internet of Things (IoT) technology to provide audiences with a more prosperous and deeper art experience.
OBJECTIVES: The primary purpose of this study is to explore how to use IoT technology to transform a painting exhibition into a digital space that can interact with the audience. By fusing art and technology, the researchers aim to promote innovation in traditional art presentations and stimulate the audience's freshness and interest in art.
METHODS: In the Smart Painting exhibition, the researchers used advanced Internet of Things (IoT) technology to incorporate the audience's movements, emotions, and feedback into the artworks through sensors, wearable devices, and cloud computing. The digital devices in the exhibition space could sense the audience's presence and generate and adjust the art content in real-time according to their movements or emotional state, creating a unique display that interacted with the audience.
RESULTS: After implementing the Smart Painting exhibition, the audience's sense of participation and immersion in the art display was significantly increased. Through IoT technology, viewers can interact with the artwork in real-time and feel a more personalized art experience. The digitized exhibition space provided the audience a new level of perception, deepening their understanding and appreciation of the artworks.
CONCLUSION: This study demonstrates the feasibility of using IoT technology to create interactive art spaces and shows that this innovation can inject new vitality into traditional painting exhibitions. Through digitalization, the interactivity of the art space is enhanced, providing the audience with a more profound art experience. This approach provides artists with new possibilities for creativity and opens up a fresh vision of participatory art for the audience. The Smart Painting Exhibition is expected to become a new model for integrating art and technology, pushing the art world towards a more innovative and open future.

Keywords: smart painting, painting exhibition, Internet of things technology, art space

Received on 21 December 2023, accepted on 1 April 2024, published on 4 April 2024

doi: 10.4108/eetsis.5375

*Corresponding Author. Email: chenchuang@zzuit.edu.cn

1. Introduction

Art exhibition has always been one of the important ways for people to appreciate and understand artworks. With the continuous development and progress of science and technology, traditional art exhibitions are also constantly innovating and evolving. Among them, intelligent painting exhibition, as a new form of art exhibition, creates an art space with interactivity and personalized experience by integrating Internet of Things (IoT) technology(Ammar et al., 2022). This paper aims to discuss the design, implementation and effect of brilliant painting exhibition, analyze its importance and significance of contemporary art, and contribute to integrating art and technology(Civan & Kurama, 2021). As a traditional way of presenting art, art exhibitions usually adopt a static display form, in which the audience can only passively appreciate the works, lacking interactivity and personalized experience. With the rapid development of information technology, people's demand for art display forms is also rising, and they hope to interact and communicate with artworks in more prosperous and diversified ways. Therefore, the traditional art exhibition form is gradually becoming difficult to meet the audience's needs and needs must be innovated and improved. At the same time, the rise of Internet of Things (IoT) technology provides new possibilities for the innovation of art exhibitions. IoT technology can connect various physical and digital devices to realize the interconnection of information, bringing more prosperous and diversified display methods for art exhibitions. Through IoT technology, art exhibitions can be digitalized and intelligentized, and they have more substantial interactivity and personalized experience, thus attracting more audience participation and attention(Pal et al., 2021). Based on the above background, an intelligent painting exhibition as a new art display form integrating the Internet of Things technology has emerged. By combining traditional paintings with modern technology, smart painting exhibition creates an art space with interactivity and personalized experience, providing the audience a brand new art experience.

The emergence of intelligent painting exhibitions not only enriches the form of art display but also promotes the integration of art and technology. First of all, intelligent painting exhibition provides a brand-new creation platform and display space for artists. Traditional paintings are usually static, and the audience can only perceive the beauty and connotation of the works through vision(Zhang et al., 2021). Through the Internet of Things (IoT) technology, the intelligent painting exhibition makes the artworks dynamic and interactive, and the artists can adjust the presentation form and content of the works in real-time through the digital device to realize a richer and more diversified artistic expression. Secondly, the smart painting exhibition gives the audience a richer and deeper art experience. Instead of passively appreciating the works, the audience can participate in the art creation process through interaction with the exhibition space, resonating and interacting with the works(Mourtzis et al., 2022). This personalized, immersive art experience enhances the audience's sense of participation and appreciation and stimulates their interest in and understanding of art. Finally, the emergence of intelligent painting exhibitions is of great significance to the development of the art and cultural and creative industries. As an important part of the cultural industry, art exhibitions can promote cultural inheritance and innovation and promote the development of the local economy and the prosperity of the cultural industry. As an innovative form of art display, intelligent painting exhibitions will attract more audience participation and attention and inject new vitality and power into the development of cultural and creative industries(Mishra et al., 2022). This study explores the design, implementation and effect of intelligent painting exhibitions and analyses their importance and significance in contemporary art. Firstly, in-depth research on the design and implementation of intelligent painting exhibitions can provide new ideas and methods for the innovation and improvement of art exhibitions. Secondly, evaluating and summarizing the effect of intelligent painting exhibitions can provide a reference for managing and operating art exhibitions(Anand et al., 2022). Finally, promoting the successful experiences and practices of intelligent painting exhibitions can promote the integration of art science and technology and the development of cultural and creative industries.

2. Background of the study

Art exhibition has always been one of the important ways for human beings to appreciate, understand and communicate art. Traditional forms of art exhibitions are often static, and the audience can only passively appreciate the works, lacking interactivity and personalized experience. However, with the continuous development and progress of science and technology, the forms of art exhibitions are also constantly innovating and evolving. Among them, intelligent painting exhibition based on Internet of Things (IoT) technology, as a new form of art exhibition, creates an art space with interactivity and personalized experience through digital and intelligent means(Zrelli, 2022). This study aims to explore the intelligent painting exhibition art space based on IoT technology, analyze its design, implementation and effect, explore its importance and significance in contemporary art, and provide new ideas and methods for integrating art and technology.

Traditional art exhibition forms often lack interactivity and personalized experience in addition to meeting the audience's basic needs to appreciate the works, making it difficult to attract the attention and participation of the audience(Piccialli et al., 2021). With the continuous development and popularization of the Internet of Things technology, digital and intelligent display forms provide new possibilities for the innovation of art exhibitions(Brass & Sowell, 2021). Intelligent painting exhibitions based on IoT technology can realize digital presentation, real-time

interaction and personalized experience of works, which greatly enriches the audience's art experience and enhances the audience's participation and satisfaction. Therefore, studying the intelligent painting exhibition art space based on IoT technology is of great theoretical and practical significance. First, studying the design and implementation of intelligent painting exhibitions can provide new ideas and methods for the innovation and improvement of traditional art exhibitions (Lutta et al., 2021). Intelligent painting exhibition combines traditional paintings with Internet of Things (IoT) technology to create an art space with interactivity and personalized experience, which provides a new art experience for the audience. An in-depth study of the design principles and implementation methods of intelligent painting exhibitions can provide references for the digital and intelligent transformation of art exhibitions(Vassilakis et al., 2021). Secondly, evaluating the effect and impact of intelligent painting exhibitions can provide reference and guidance for the management and operation of art exhibitions. As a new type of art exhibition form, intelligent painting exhibitions' effect and impact must be objectively assessed and summarized(Morris et al., 2021). By analyzing the audience feedback, participation, and artwork display effects of intelligent painting exhibitions, the Author can discover its advantages and shortcomings and provide a basis for further improvement and optimization. Finally, the research of intelligent painting exhibitions is of great significance in promoting the integration of art and technology and the development of cultural and creative industries(Smart et al., 2021). The integration of art, science and technology is one of the important trends in the development of today's society, and the intelligent painting exhibition, as a typical case of the combination of art, science and technology, can provide examples and references for promoting the communication and cooperation between art and science and technology. At the same time, the promotion and application of intelligent painting exhibitions will also inject new vitality and power into the development of cultural and creative industries.

An in-depth study of intelligent painting exhibition art space based on Internet of Things technology can provide new ideas and methods for the innovation and improvement of art exhibitions (Korzun et al., 2022). As a new art exhibition form, intelligent painting exhibition design, implementation and effect have certain specificity and complexity(Pistofidis et al., 2021). Systematically analyzing the design principle, implementation method, and effect evaluation index of intelligent painting exhibitions can provide a reference for traditional art exhibitions' digital and intelligent transformation. Secondly, evaluating the effect and impact of intelligent painting exhibitions can provide reference and guidance for the management and operation of art exhibitions. As a new art exhibition, an intelligent painting exhibition needs to be objectively evaluated and summarized in terms of audience feedback, participation, and the effect of artwork display. Analyzing the advantages and shortcomings of intelligent painting exhibitions can provide a basis for further improvement and optimization. Finally, the research of intelligent painting exhibitions is of great significance in promoting the integration of art and technology and the development of cultural and creative industries.

Art exhibition has always been one of the important forms of human cultural exchange and art inheritance. With the continuous development of science and technology, the traditional form of art exhibition is experiencing a digital and intelligent revolution. In this context, the intelligent painting exhibition art space based on Internet of Things (IoT) technology comes into being, providing a new possibility for combining art and technology. This study aims to explore the significance and purpose of this emerging field of research. Traditional art exhibition forms are often limited to static display methods, and the audience lacks interactivity and participation. The intelligent painting exhibition art space based on IoT technology provides the audience with a richer and more personalized art experience through digital and intelligent means. The emergence of this new exhibition form will promote the innovative development of art exhibitions and enrich people's cultural life(Baqer et al., 2022). Traditional art exhibitions are often limited by space and time constraints, and artworks are displayed in a relatively single way. The intelligent painting exhibition art space based on the Internet of Things technology can break through the limitations of traditional exhibitions, presenting the artworks to the audience through digitalization and interactivity, which greatly expands the display methods and carriers of artworks (Li et al., 2022). An intelligent painting exhibition art space is a typical representation of the integration of art and technology, which combines traditional painting art with advanced Internet of Things technology to create a new art experience(Sadeeq & Zeebaree, 2021). The study of intelligent painting exhibition art space helps to promote the integration of art science and technology and promotes interdisciplinary cooperation and communication. Today's society is in an era of rapid technological development, and combining art and technology has become an important trend. The study of intelligent painting exhibition art space based on Internet of Things (IoT) technology helps researchers to better grasp the future development trend of art and technology. It provides new ideas and directions for the development of the cultural industry.

This study aims to explore the design principle of intelligent painting exhibitions based on IoT technology in depth, including digital display, interactivity design, data collection, and analysis. By analyzing the design principles, it can provide theoretical support and guidance for the implementation of intelligent painting exhibitions. This study will analyze the implementation method of intelligent painting exhibition, including the selection of hardware equipment, the development of a software system, the establishment of network connection and other aspects. The study of implementation methods can provide technical support and guidance for implementing intelligent painting exhibitions. This study will evaluate the effect and impact of the intelligent painting exhibition, including audience

participation, exhibition feedback, and the effect of artwork display(Roe et al., 2022). Through objective assessment, the strengths and weaknesses of the intelligent painting exhibition can be found, providing a basis for the improvement and optimization of the exhibition. This study will explore the future development trend and prospect of intelligent painting exhibitions based on IoT technology. Exploring future development trends can provide references for intelligent painting exhibitions' continuous innovation and development. To summarize, studying intelligent painting exhibition art space based on IoT technology has important theoretical and practical significance(Ceipek et al., 2021). Through in-depth study of the design, implementation and effect of intelligent painting exhibitions, it can promote the innovative development of art exhibitions, promote the integration of art and technology, expand the way of displaying artworks, and inject new vitality and power into the development of the cultural industry.

3. Research methodology

3.1 Field research and case studies

A field study was conducted to understand the existing smart painting exhibitions that utilize IoT technology to create interactive art spaces, including the design concepts of the exhibitions, the application of the technology, and the feedback from the audience. First, some smart painting exhibitions are selected, including different exhibitions in art galleries and museums. Observation, interviews and other methods are utilized to gain an in-depth understanding of each exhibition's design concept, technology application and implementation process. Through field research, collect data from the exhibition site, audience feedback and other information to evaluate and analyze the effect of the exhibition. The process of creating an interactive art space with IoT technology (I) is shown in Figure 1.

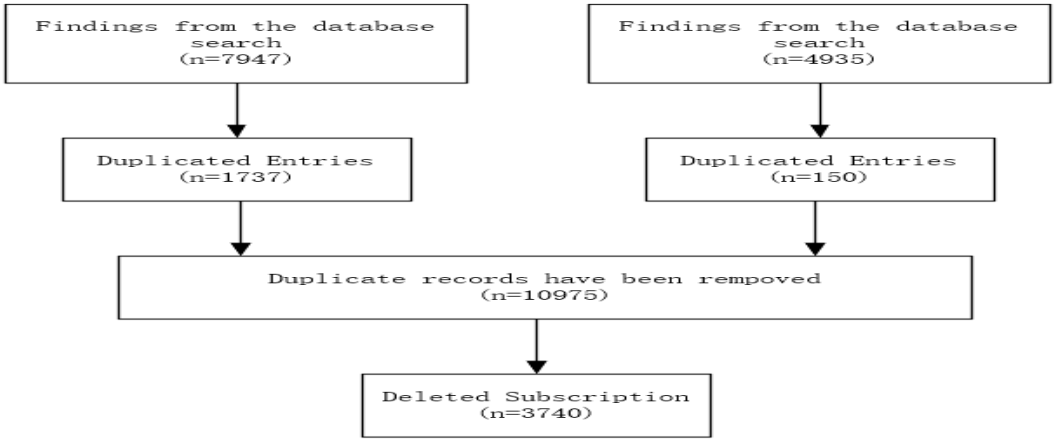

Figure 1 Process of creating interactive art spaces with IoT technology (I)

The purpose of case analysis and comparison is to summarize the successes and shortcomings of using IoT technology to create interactive art spaces in smart painting exhibitions by analyzing and comparing existing cases to provide a reference for this study. A certain number of smart painting exhibition cases are selected for in-depth analysis. Provide a detailed description of each case, including the exhibition's background, the design concept, the application of technology, audience feedback and so on. Compare and analyze the similarities and differences between each case, and summarize the successes and shortcomings. Organize, analyze and summarize the data obtained from the field research and case studies to provide empirical support for the study. Organize and summarize the data obtained from field research and case study analysis. Use statistical methods to analyze the data, such as frequency and correlation analysis. Combine the results of the field research and case study analysis to summarize the characteristics, advantages and shortcomings of using IoT technology to create interactive art spaces in smart painting exhibitions. The process of creating interactive art space by IoT technology (II), as shown in Figure 2.

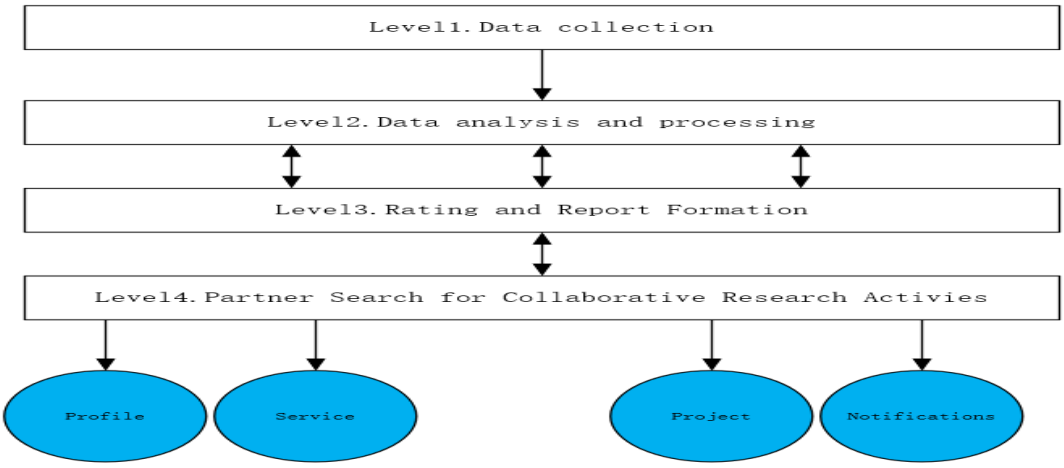

Figure 2 Process of creating interactive art spaces with IoT technology (II)

The study's results are presented and discussed to analyze the current situation and development trend of using IoT technology to create interactive art spaces in smart painting exhibitions. Present the results of data analysis clearly in the form of charts and tables. To analyze and discuss the research results in depth and explore the optimization strategy and future development direction of IoT technology to create interactive art space in smart painting exhibitions. Based on the research results, conclusions and recommendations are presented to guide the practice of creating interactive art spaces using IoT technology in smart painting exhibitions. Summarize the development trend and optimization strategy of intelligent painting exhibitions based on the research results. Suggestions and practical guidance for utilising IoT technology to create interactive art spaces for intelligent painting exhibitions are presented.

3.2 Experimental design and technology development

Through experimental design and technology development, the Author explores ways to utilize IoT technology to create an interactive art space in a smart painting exhibition to enhance audience engagement and exhibition experience. Create an exhibition space that is artistic, innovative and interactive in the design and construction of the experimental space. Design the exhibition space layout, considering factors such as audience flow light and shadow effects. Select appropriate IoT technology devices, such as sensors, smart projections, etc. Develop a plan for digitization of artworks to enable interaction with IoT technology.

In selecting and commissioning technical equipment, select appropriate IoT technical equipment and ensure that they work together. Select IoT technology devices such as sensors, projection devices, interactive screens, etc., and consider their compatibility and interactive effects. Carry out the equipment's construction and debugging to ensure the technologies can work together. Digitization of artworks and interactive design, innovatively digitize artworks and design solutions for interaction with the audience. Digitize artworks and transform them into formats that can interact with IoT technologies—designing audience interaction methods, such as gesture recognition, voice control, etc., to enable two-way interaction between the audience and the artwork.

Data collection and analysis is collected through experiments to assess the effect of audience interaction and exhibition experience. Install cameras, sensors, and other devices to record the interactive behaviour of the audience in the exhibition space. Collect interactive data, including the number of viewers, frequency of interaction, and feedback. Use statistical analysis methods to compare the effects of different interactive designs and analyze changes in audience engagement. In terms of technology optimization and improvement, the IoT technology of the exhibition space is optimized and improved based on the data analysis results. Analyze the experimental data to identify the areas and solutions with better and worse interactive effects. Make technical adjustments and improvements, such as optimizing sensor sensitivity and improving interactive interfaces. Continuously test and adjust, iteratively improve technical solutions to enhance the overall exhibition interactive experience.

Audience feedback is collected and analyzed for the audience's feelings and opinions about the interactive art space. Design an audience feedback questionnaire to collect their subjective evaluation of the interactive exhibition. Conduct face-to-face interviews to better understand the audience's experience, feelings and suggestions. Analyze and combine the audience feedback data with the experimental data to comprehensively evaluate the interactive effect. Present and discuss the experimental results to summarize the successes and shortcomings of the

innovative interactive art space. Produce charts, videos, and other multimedia materials about the exhibition. Conduct in-depth analysis and discussion of the experimental process and data to explore the potential impact and development trend of the innovation of interactive art space. Refine the study's conclusions to guide using IoT technology to create interactive art spaces in smart painting exhibitions. Summarize the experimental results and emphasize the advantages and achievements of innovative interactive design. Propose directions and recommendations for future development to guide further improvements in the application of IoT technology in smart painting exhibitions.

IoT technology is utilized to create interactive art space models, as shown below:

$$N(t)=\frac{K}{1+\exp[-\frac{\ln(81)}{dt}(t-t_m)]} \quad (1)$$

Where the *N(t)* function is a Tirecorre function, i.e., the independent variables of the function can only take positive integer values.

$$Q_v : A \to R^v \quad (2)$$

$$P(a_i)=\left\{p_j \in P \mid (a_i, p_j) \in u\right\}, i=\overline{1,n},\ j=\overline{1,m} \quad (3)$$

$$e(a_i)=\sqrt{\sum_{y=1}^{h(a_i)} \| C(p_y) \| -(h(a_i))^2} \quad (4)$$

$$i_{10}(a_i)=\| C^{10}(a_i) \| \quad (5)$$

In Equation (2), the range of values of Qv needs to be taken from the constant A to the Vth power of R. In Equation (3), P(ai) is the conditional probability function; in Equation (4), e(a_i) is the sequence of standard deviations of the function; and in Equation (5), the absolute value is taken to calculate the error of $i_{10}(a_i)$.

4. Results and discussion

4.1 Application of Internet of Things (IoT) Technology in Smart Painting Exhibition and Evaluation of Interactive Effects

The Smart Painting Exhibition uses IoT technology to create a new art viewing experience. In the exhibition space, the researchers used various IoT technology devices, including sensors, intelligent projection, interactive screens, etc., to realize a two-way interaction between the audience and the artworks using the digitized artworks as the carrier. These technological devices were skillfully integrated into the exhibition space, enhancing the display effect of the artworks and the audience's sense of participation and immersion. First, the researchers used sensor technology to monitor and track the audience's position. By placing sensors in all corners of the exhibition space, the researchers could accurately capture the audience's position and movement trajectory. This provides important data support for the subsequent interactive design, enabling the researchers to adjust the exhibition content and interactive methods according to the audience's positional changes, thus realizing a more personalized and precise interactive experience. Second, using intelligent projection technology, the researchers digitized the artworks and projected them on the walls or floor of the exhibition space. This new form of display expands the traditional way of displaying paintings and provides the audience with a richer and more diverse visual experience. The audience can touch, drag and drop the projected artworks to interact with them in real-time and feel the vividness and vitality of the artworks. Finally, the researchers designed a variety of interactive screens that realize the interaction between the audience and the artworks through voice control, gesture recognition and other technologies. The audience can manipulate the images or videos on the screen through simple gestures or voice commands to participate in the art creation process. This kind of interaction is both interesting and capable of stimulating the creativity and imagination of the audience, making a closer connection between the audience and the artwork. The trend of the Smart Painting exhibition (I), (II) and (III) is shown in Figures 3, 4 and 5.

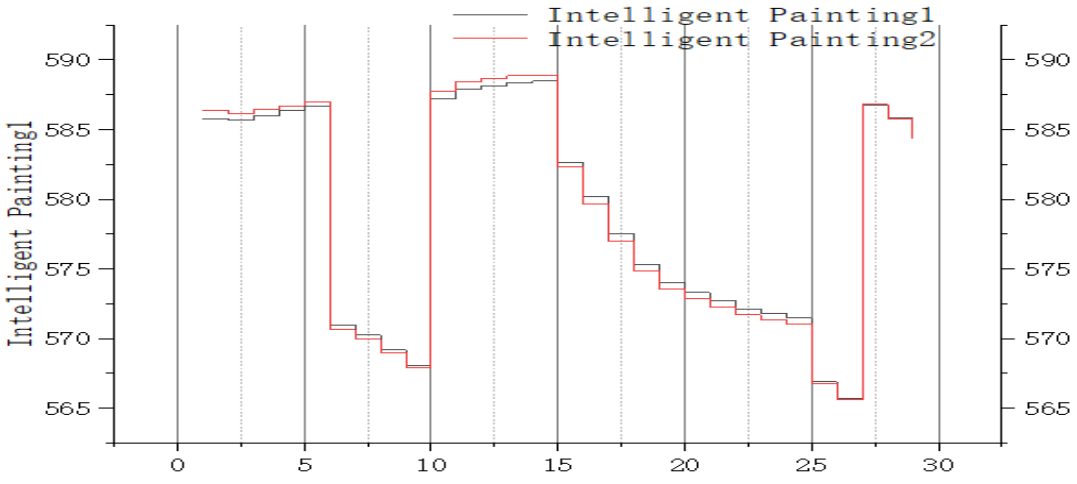

Figure 3 Trend of smart painting exhibitions (I)

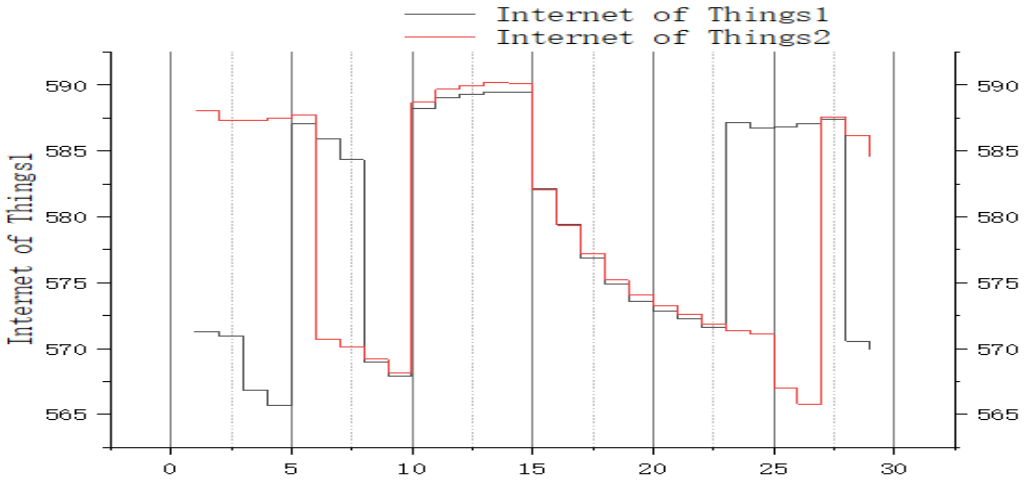

Figure 4 Trends in Smart Drawing Exhibitions (II)

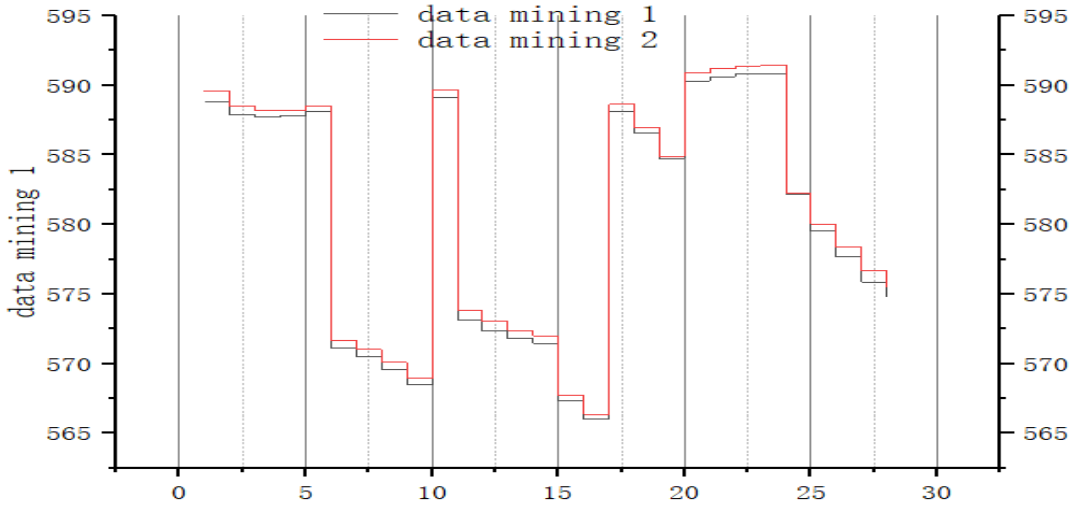

Figure 5 Trend of Smart Drawing Exhibitions (III)

The researchers conducted a series of field observations and data analysis to assess the interactive effects of IoT technologies in the Smart Painting exhibition. First, the researchers recorded the audience's interactive behaviour and engagement through cameras and sensor devices installed in the exhibition space. Observations showed that the vast majority of the audience was interested in the interactive installations in the exhibition, actively participated in the interactive experience, and showed high satisfaction and curiosity. Secondly, the researchers collected feedback data from the audience to understand their subjective feelings about the interactive experience of

the exhibition through questionnaires and face-to-face interviews. Most of the visitors said that the IoT technology devices in the exhibition brought them a new viewing experience, enabling them to understand and appreciate the artworks more deeply. Especially for the younger generation of visitors, this novel interactive approach is more attractive and participatory, making them more willing to spend time and energy exploring and experiencing. Finally, the researchers conducted a statistical analysis and comprehensive assessment of the audience interaction data. By comparing the frequency of use and audience participation of different interactive devices, the researchers found that voice-activated and gesture-recognition technologies were more popular among the audience, who were more inclined to use these simple and intuitive interactive methods. The sensor monitoring technology, on the other hand, although not directly interacting with the audience, played a key role in adjusting the content and layout of the exhibition and was highly recognized by the exhibition planners. In summary, the interactive art space created by utilizing IoT technology in the Smart Painting exhibition has achieved remarkable and successful results. This new mode of exhibition viewing not only enriches the cultural life of the audience but also brings more possibilities for artistic creation and display and injects new vitality into the development and innovation of the cultural industry.

4.2 Analysis of the Influencing Factors of Audience Participation and Exhibition Experience in Smart Painting Exhibitions

The attractiveness of the exhibition content is one of the key factors affecting audience engagement and the exhibition experience. In smart painting exhibitions, factors such as the quality of the artworks, the novelty of the theme, and the relevance to contemporary society and culture all affect the audience's interest and participation. Works with unique artistic styles and in-depth connotations tend to attract more viewers to stop and watch and trigger their thinking and emotional resonance. At the same time, the compatibility of the theme presented by the artworks with the background of the times is also an important factor for audience participation. If the exhibition's content can reflect the current hot topics in society or trigger the audience's thinking, then the audience will be more willing to invest time and energy to deeply understand and participate in the exhibition. The diversity of interactive methods is another important factor affecting audience participation in smart painting exhibitions. In the exhibition design, using various interactive methods can provide a richer and more flexible participation experience to meet the needs and preferences of different audience groups. For example, technical means such as voice control, gesture recognition, and touchscreen interaction can allow the audience to interact with the artworks in different ways, thus stimulating their curiosity and desire for exploration. In addition, setting up interesting interactive links such as interactive games and photo punch points can also increase audience participation and the interactivity of the exhibition and enhance the overall exhibition experience.

The layout design of the exhibition space also has an important impact on audience participation and exhibition experience. A reasonable and comfortable exhibition space layout can provide the audience with a good viewing environment and enhance their desire to participate and experience. In the intelligent painting exhibition, the display position of the artworks should be reasonably set to ensure that the audience can browse and appreciate the works smoothly, and enough rest area and communication space should be set so that the audience has the opportunity to share the viewing experience and interactive experience with others. In addition, the atmosphere and lighting design of the exhibition space also need to consider the comfort and experience of the audience, creating an exhibition scene with an artistic atmosphere and interactive fun. Exhibition interpretation and guidance is one of the important factors affecting audience participation and exhibition experience. In intelligent painting exhibitions, providing explanatory notes, interactive guidance, and guiding services for artworks can help audiences better understand the exhibition content and the backstory of artworks and enhance their sense of participation and depth of cognition. At the same time, the professionalism and service attitude of the exhibition staff will also have a direct impact on the audience's experience. Friendly and patient service attitude and professional answering ability can make the audience feel respected and cared for and enhance their satisfaction and participation. Individual audience factors will also have an impact on participation and exhibition experience. Different ages, genders, educational backgrounds, cultural literacy, and other factors will affect the audience's interest in and participation in the exhibition. For example, young people are more interested in novel and avant-garde art forms and interactive methods, while older people may pay more attention to the tradition and classicism of artworks. Therefore, when designing smart painting exhibitions, it is necessary to comprehensively consider the needs and preferences of different audience groups and provide diversified exhibition content and interactive experiences to attract a wider range of audience groups to participate in the exhibition.

To summarize, the influencing factors of audience participation and exhibition experience in intelligent painting exhibition are multifaceted, including the attractiveness of the exhibition content, the diversity of interactive methods, the layout design of the exhibition space, the exhibition explanation and guidance, and the individual factors of the audience, etc. By comprehensively considering and reasonably designing these factors, the Author can effectively enhance the audience participation and exhibition experience. Through careful consideration and rational design of these factors, audience participation and exhibition experience can be effectively enhanced, creating a more attractive and interactive exhibition space

for intelligent painting. The application levels of interactive tools (i), (ii), and (iii) are shown in Figures 6, 7 and 8.

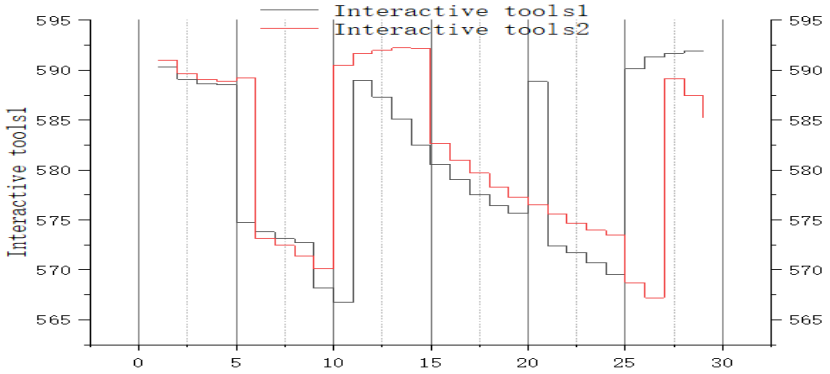

Figure 6 Level of application of interaction tools (i)

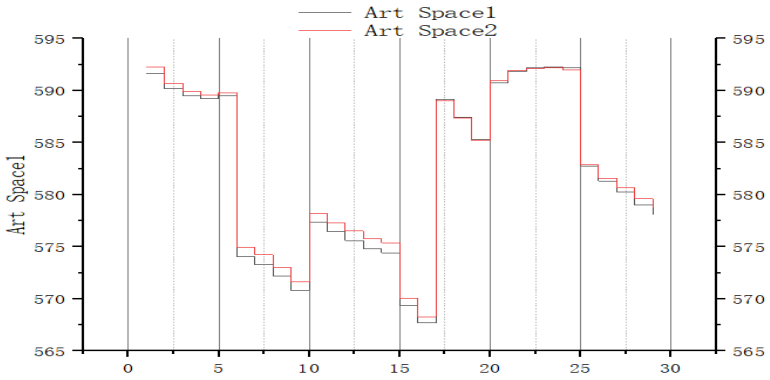

Figure 7 Level of application of interaction tools (ii)

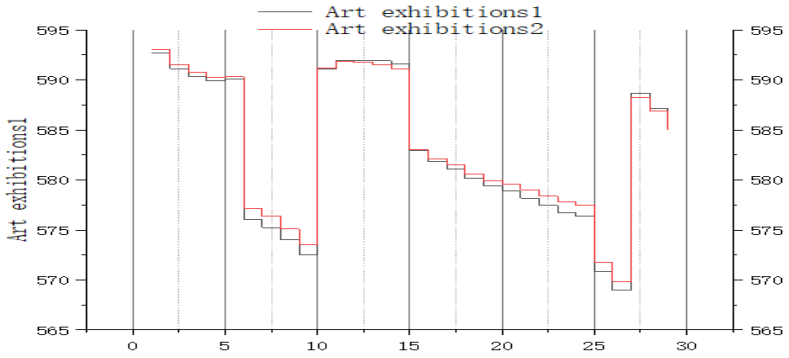

Figure 8 Level of application of interaction tools (iii)

4.3 Intelligent painting exhibition art space based on Internet of Things technology

Smart painting exhibition is a form of display that integrates art and technology, and through the application of IoT technology, it can create a richer and more interactive art experience for the exhibition space. In the researchers' study, the researchers used IoT technology, including sensors, smart devices, and network communications, to build a smart painting exhibition art space. The researchers realized an innovative layout and design for the exhibition space through IoT technology. The arrangement of sensors and smart devices allows viewers to interact with the artworks in real-time. For example, through the touch sensors installed next to the artworks, the audience can change the colour or movement trajectory by touch, thus realizing an interactive experience with the artworks. In addition, the researchers also designed an intelligent tour guide system. Through the sensors and speakers installed in the exhibition space, viewers can access explanations and information related to the artworks through their smartphones or tablets, which enhances the audience's participation and exhibition experience. In the Smart Painting exhibition, the digital display and creation of artworks are also the focus of researchers. Through IoT technology, researchers can digitize traditional paintings and display them in the exhibition space in various forms, including projection and virtual reality. At the same time, researchers can also provide artists with platforms and support for creation through smart devices and software tools. For example, using smart drawing boards and digital pens, artists can create on electronic canvases and transmit

their works in real-time to the exhibition space for display, which realizes the digitization and intelligence of art creation and display.

By creating a smart painting exhibition art space based on IoT technology, the researchers have enhanced audience engagement and experience. The audience can understand and appreciate the works more deeply by interacting with the artworks and creating emotional resonance with them. The application of the intelligent guide system also provides the audience with a more convenient and enriched experience of visiting the exhibition, allowing them to explore and feel the exhibition space more freely. In addition, the application of digital display and creation also brings a new art experience to the audience, expanding their knowledge and understanding of art. Through this study, the researchers realized the integration and innovation of technology and art and provided new ideas and methods for creating intelligent painting exhibition art space. IoT technology brings richer and more diverse display forms to art exhibitions and provides more opportunities for artists and audiences to create and participate. The researchers believe that under the continuous development and application of IoT technology, smart painting exhibitions will show a more diversified and intelligent development trend and bring a richer and more in-depth art experience to the audience. Creating a smart painting exhibition art space based on IoT technology is a research work with innovative significance and practical value. Through IoT technology, the researchers have successfully realized the exhibition space's digitization, intelligence and interactivity, bringing a new art experience to the audience. The researchers believe that with the continuous development of technology and the continuous innovation of art, the intelligent painting exhibition art space based on IOT technology will show a broader development prospect and application prospect in the future.

5. Conclusion

Smart painting exhibition is an innovative art display that successfully creates interactive art space using Internet of Things (IoT) technology. This research aims to explore how traditional painting exhibitions can be combined with modern technology to provide audiences with a richer and deeper art experience. In this thesis, the researchers discuss the design, implementation and effects of smart painting exhibitions and their impact on how art is displayed. First, by analyzing existing forms of art exhibitions and the development of IoT technology, the researchers identified the concept and design framework of smart painting exhibitions. The researchers chose a series of advanced IoT technologies, including sensors, wearable devices and cloud computing, to construct a digital exhibition space that can sense the presence of and interact with the audience. Through these technological tools, viewers can interact with the artworks in real-time, resulting in a more personalized and immersive art experience. Second, the researchers carried out the actual design and implementation of the smart painting exhibition. In the exhibition space, the researchers set up multiple digital devices that can sense the audience's movements, emotions and feedback and generate and adjust the art content in real-time according to them. Viewers can interact with the exhibition space through gestures, sounds, or body movements, influencing the artwork presentation's form and content. This real-time, personalized interaction mechanism brings a new art experience to the audience, stimulating their freshness and interest in art. Finally, the researchers evaluated and summarized the effects of the smart painting exhibition. Through surveys and observations after the implementation of the exhibition, the researchers found that the audience's sense of participation and immersion in the art display was significantly increased. They became interested in the digital installations in the exhibition space, actively participated in the exhibition, and demonstrated a deeper understanding and appreciation of the artworks. This innovative exhibition form enriches the traditional art presentation and provides the audience with a more personalized and interactive art experience.

In summary, the intelligent painting exhibition has successfully created an interactive art space through Internet of Things technology, providing a new art experience for the audience. This innovation not only enriches the form of art display but also promotes the integration of art and technology, bringing new opportunities and challenges to the development of the art field. The researchers believe intelligent painting exhibitions will become an important direction for future art displays, bringing audiences a richer and deeper art experience and promoting cross-border innovation between art and technology.

Acknowledgements.

This work is supported by Research Project on Industry-Education Integration in Undergraduate Schools in Henan Province 2023: *Research and Practice on Quality Digital Resource Platform of the Application-oriented Undergraduate Schools in the Context of Industry-Education Integration and School-Enterprise Cooperation*.

References

[1] Ammar, M., Haleem, A., Javaid, M., Bahl, S., Garg, S. B., Shamoon, A., & Garg, J. (2022). Significant applications of smart materials and the Internet of Things (IoT) in the automotive industry. *Materials Today: Proceedings*, *68*, 1542–1549. https://doi.org/10.1016/j.matpr.2022.07.180

[2] Anand, P., Singh, Y., Selwal, A., Singh, P. K., & Ghafoor, K. Z. (2022). IVQFIoT: An intelligent vulnerability quantification framework for scoring Internet of Things vulnerabilities. *Expert Systems*, *39*(5), e12829. https://doi.org/10.1111/exsy.12829

[3] Baqer, N. S., Mohammed, H. A., Albahri, A., Zaidan, A., Al-Qaysi, Z., & Albahri, O. (2022). Development of the Internet of Things sensory technology for ensuring proper indoor air quality in hospital facilities: Taxonomy analysis, challenges, motivations, open issues and recommended

solution. *Measurement*, *192*, 110920.

[4] Brass, I., & Sowell, J. H. (2021). Adaptive governance for the Internet of Things: Coping with emerging security risks. *Regulation & Governance*, *15*(4), 1092–1110. https://doi.org/10.1111/rego.12343

[5] Ceipek, R., Hautz, J., De Massis, A., Matzler, K., & Ardito, L. (2021). Digital transformation through exploratory and exploitative Internet of things innovations: The impact of family management and technological diversification. *Journal of Product Innovation Management*, *38*(1), 142–165. https://doi.org/10.1111/jpim.12551

[6] Civan, L., & Kurama, S. (2021). A review: Preparation of functionalised materials/smart fabrics that exhibit thermochromic behaviour. *Materials Science and Technology*, *37*(18), 1405–1420. https://doi.org/10.1080/02670836.2021.2015844

[7] Korzun, D., Semenov, A., & Balandin, S. (2022). Exhibition area digitalization using IoT sensors and applications to smart tourism services. *2022 31st Conference of Open Innovations Association (FRUCT)*, 109–114. https://doi.org/10.23919/FRUCT54823.2022.9770923

[8] Li, K., Cui, Y., Li, W., Lv, T., Yuan, X., Li, S., Ni, W., Simsek, M., & Dressler, F. (2022). When the Internet of Things meets metaverse: Convergence of physical and cyber worlds. *IEEE Internet of Things Journal*, *10*(5), 4148–4173. https://doi.org/10.1109/JIOT.2022.3232845

[9] Lutta, P., Sedky, M., Hassan, M., Jayawickrama, U., & Bastaki, B. B. (2021). The complexity of Internet of things forensics: A state-of-the-art review. *Forensic Science International: Digital Investigation*, *38*, 301210. https://doi.org/10.1016/j.fsidi.2021.301210

[10] Mishra, M., Lourenço, P. B., & Ramana, G. V. (2022). Structural health monitoring of civil engineering structures using the Internet of things: A review. *Journal of Building Engineering*, *48*, 103954. https://doi.org/10.1016/j.jobe.2021.103954

[11] Morris, A., Guan, J., & Azhar, A. (2021). An xi mixed-reality internet-of-things architectural framework toward immersive and adaptive smart environments. *2021 IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMAR-Adjunct)*, 68–74. https://doi.org/10.1109/ISMAR-Adjunct54149.2021.00024

[12] Mourtzis, D., Panopoulos, N., & Angelopoulos, J. (2022). Production management guided by the industrial Internet of Things and adaptive scheduling in smart factories. In *Design and operation of production networks for mass personalization in the era of cloud technology* (pp. 117–152). Elsevier.

[13] Pal, D., Zhang, X., & Siyal, S. (2021). Prohibitive factors to accepting Internet of Things (IoT) technology in society: A smart-home context using a resistive modelling approach. *Technology in Society*, *66*, 101683. https://doi.org/10.1016/j.techsoc.2021.101683

[14] Piccialli, F., Bessis, N., & Cambria, E. (2021). Guest editorial: Industrial Internet of Things: Where are we and what is next? *IEEE Transactions on Industrial Informatics*, *17*(11), 7700–7703. https://doi.org/10.1109/TII.2021.3086771

[15] Pistofidis, P., Ioannakis, G., Arnaoutoglou, F., Michailidou, N., Karta, M., Kiourt, C., Pavlidis, G., Mouroutsos, S. G., Tsiafaki, D., & Koutsoudis, A. (2021). Composing smart museum exhibit specifications for the visually impaired. *Journal of Cultural Heritage*, *52*, 1–10. https://doi.org/10.1016/j.culher.2021.08.013

[16] Roe, M., Spanaki, K., Ioannou, A., Zamani, E. D., & Giannakis, M. (2022). Drivers and challenges of the Internet of things diffusion in smart stores: A field exploration. *Technological Forecasting and Social Change*, *178*, 121593. https://doi.org/10.1016/j.techfore.2022.121593

[17] Sadeeq, M. A., & Zeebaree, S. (2021). Energy management for the Internet of Things via distributed systems. *Journal of Applied Science and Technology Trends*, *2*(02), 80–92. https://doi.org/10.38094/jastt20285

[18] Smart, T., Counsell, G., & Quinnell, R. (2021). The impact of immersive exhibit design on visitor behaviour and learning at Chester Zoo, UK. *Journal of Zoo and Aquarium Research*, *9*(3), 139–149.

[19] Vassilakis, C., Poulopoulos, V., Antoniou, A., Wallace, M., Lepouras, G., & Nores, M. L. (2021). exhistory: Smart self-organizing exhibits. *Big Data Platforms and Applications: Case Studies, Methods, Techniques, and Performance Evaluation*, 91–111. https://doi.org/10.1007/978-3-030-38836-2_5

[20] Zhang, J., Guo, M., Li, B., & Lu, R. (2021). A transport monitoring system for cultural relics protection based on blockchain and the Internet of Things. *Journal of Cultural Heritage*, *50*, 106–114. https://doi.org/10.1016/j.culher.2021.05.007

[21] Zrelli, A. (2022). Hardware, software platforms, operating systems and routing protocols for Internet of Things applications. *Wireless Personal Communications*, *122*(4), 3889–3912. https://doi.org/10.1007/s11277-021-09116-5