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IoT Product Design for User Experience and Technological Innovation in Virtual Reality Environments

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Abstract

INTRODUCTION: The rapid development of virtual reality technology and the Internet of Things (IoT) has provided new possibilities for user experience, and a variety of new products have emerged, especially in the field of painting, where the combination of these two provides a new platform for innovative artistic expression.
OBJECTIVES: This study takes IoT products in the art field as an example to analyze the user experience in virtual reality environments and the impact of technological innovations on IoT products, as well as to explore the potentials and limitations of this emerging form of products and forms of painting.
METHODS: In this study, the author constructed a virtual reality painting environment, utilized IoT technology to collect data from the user's painting process, and combined quantitative and qualitative analysis methods to assess user experience and technological innovation comprehensively.
RESULTS: In the virtual reality environment, the user experience was significantly improved, and the users were more immersed in the painting process and felt more robust creativity and expression. Meanwhile, the application of Internet of Things (IoT) technology also provides more possibilities for drawing; for example, using smartpens makes the drawing process more smooth and natural.
CONCLUSION: IoT painting with user experience and technological innovation in a virtual reality environment can provide a new creative platform for artists and bring a richer artistic experience to the audience, showing the feasibility and broad prospect of IoT products based on a virtual reality environment.

Keywords: virtual reality, technological innovations, virtual reality environments, innovative artistic expression

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1. Introduction

Virtual Reality (VR) technology and the Internet of Things (IoT) are two cutting-edge technologies that are getting much attention in the information technology field today(Lee et al., 2021). With the continuous development of technology, virtual reality has gradually stepped out of the framework of science fiction and become a part of real life. At the same time, IoT connects everything between people and things, making an intelligent and connected lifestyle more possible(Park & Kim, 2022). The combination of the two has shown great potential in many fields, and the products developed based on the two have great potential and revolutionary, which is discussed in this paper using painting as an example.

Painting has been constantly evolving and innovating as an ancient art form. However, with the advancement of science and technology, the way of painting has also quietly changed. Painting in virtual reality environments has attracted more and more attention as a new form of artistic expression that combines modern technology(Mikalef et al., 2021). In this new field of painting, users can immerse themselves in a virtual art space and create by manipulating virtual tools, which offer a higher degree of freedom and interactivity than traditional painting methods.

User experience and technological innovation in virtual reality environments are crucial in developing IoT painting(Zorkin & Ivanova, 2022). Improving user experience can attract more artists and audiences to participate, making art creation and appreciation more vivid and attractive. The continuous advancement of technological innovation provides artists with more creative possibilities, enabling them to realize more colorful creative imagination in the virtual environment(Van Kerrebroeck et al., 2021). Therefore, an in-depth study of IoT painting in a virtual reality environment with user experience and technological innovation is of great significance for exploring the new boundaries of art and expanding the new possibilities of painting.

However, while user experience in virtual reality environments with technologically innovative IoT paintings presents several advantages and potentials, it also faces several challenges and limitations(Zhang et al., 2022). For example, the high cost of technological equipment, the uneven level of technology, and the standardization of user experience have constrained the further development of the field. Therefore, further in-depth research is needed to explore how to overcome these obstacles and promote the healthy development of the field of IoT painting with user experience and technological innovation in virtual reality environments.

IoT painting for user experience and technological innovation in virtual reality environments presents challenges and opportunities. Solving these challenges will provide new directions for artists and technicians to develop and bring richer art experiences to users(Wang et al., 2023). Therefore, this study will delve into the IoT painting of user experience and technological innovation in a virtual reality environment and analyze its potential applications and impacts in the field of art so as to provide theoretical support and practical references for future research and practice in related fields.

Against this background, this paper will take a systematic research approach, combining an in-depth understanding of virtual reality technology, IoT technology, and the art of painting to explore the impact of user experience and technological innovation on IoT painting in virtual reality environments using experimental design and data analysis, to provide new ideas and perspectives for further research in related fields(Deepu & Ravi, 2023). The in-depth exploration of this study will enable a better understanding of IoT painting with user experience and technological innovation in a virtual reality environment, reveal its intrinsic mechanisms and characteristics, provide innovative inspiration and guidance for artists, designers, and technicians, and promote the development and application of this field(Lee et al., 2021). At the same time, it will also provide valuable research results and practical experience for academia and industry and promote the in-depth integration and application of virtual reality technology and IoT technology in the field of art so as to realize the win-win situation of artistic innovation and technological development.

2. Background of the study

2.1 Virtual Reality

Virtual reality is a technology that enables users to interact with the virtual world through computer-generated three-dimensional images and environments(Han et al., 2022). This technology utilizes hardware such as head-mounted displays, handheld controllers, tracking devices, and virtual reality software to simulate the real world or fictional environments to give users a sense of immersion(Mosteanu & Faccia, 2021). With the continuous progress of computer graphics, perception technology, and human-computer interaction technology, virtual reality technology has gradually moved from science fiction movies into real life and has shown broad application prospects in entertainment, education, medicine, and other fields.

The development of virtual reality technology has a long history and has been involved as early as the 1960s. With the improvement of computer performance and the maturity of graphics processing technology, virtual reality technology has gradually become a research hotspot in academia and industry. In 1987, the Virtual Reality Society was founded, marking the formal entry of virtual reality technology into the professional field(Deepu & Ravi, 2023). Since then, virtual reality technology has developed rapidly, and many research institutions, academic journals, and industrial companies related to it have emerged, promoting continuous innovation and development in the field.

The basic principle of virtual reality technology is to simulate the real world or fictional environment by computer and to transmit information to the user through visual, auditory, tactile, and other perception channels so that the user can feel in the real world. Among them, vision is the most crucial perception channel, and head-mounted displays are usually used to present images of the virtual world(Boem & Turchet, 2024). These head-mounted displays are equipped with high-resolution displays and head-tracking systems that can track the user's head movements in real-time and adjust the display content according to changes in the user's viewing angle, making the user feel that he or she is in a virtual environment.

In addition to vision, virtual reality technology also utilizes a variety of perceptual channels, such as auditory, tactile, and motion perception, to enhance the user's sense of immersion and realism(Ge et al., 2021). For example, stereo sound effects are provided through audio devices to make users feel that the sound comes from different directions; haptic feedback devices simulate the tactile sensation of objects to enable users to feel the texture and shape of virtual objects; and motion sensing devices capture the user's body movements to enable the user to move and interact freely in the virtual environment.

The application fields of virtual reality technology are vast, involving entertainment, education, medical treatment, military, and other fields. Virtual reality technology is widely used in games, film, and television production, providing users with immersive entertainment experiences (Chiang et al., 2021). In education, virtual reality technology is used in teaching activities such as simulated experimental environments and virtual reality roaming, improving students' learning interest and participation(Uhlenkamp et al., 2022). In the medical field, virtual reality technology is used in surgical simulation, rehabilitation training, etc., providing doctors and patients with safer and more effective medical services. In the military, virtual reality technology is used in simulation training, battlefield scenario analysis, etc., improving military personnel's training efficiency and combat effectiveness.

As a new type of interactive technology, virtual reality technology is showing broad application prospects in various fields due to its unique advantages and potential. With the continuous progress of hardware technology and the continuous innovation of software technology, virtual reality technology will bring people more prosperous and diversified experiences and promote the progress and development of human society.

2.2 Application of IoT in Virtual Reality

The Internet of Things (IoT), an emerging information technology, refers to a technical system that realizes the sensing, identification, localization, and control of various objects in the real world through the interconnection of various sensors, devices, and objects. With the continuous development and popularization of IoT technology, its combination with virtual reality technology brings people brand new application scenarios and experience methods.

IoT provides more prosperous and more accurate data support for perception and interaction in virtual reality environments. In traditional virtual reality environments, users can usually only interact with the virtual world through head-mounted displays and handheld controllers and are unable to perceive objects and environments in the real world(Zamani et al., 2022). With the introduction of IoT technology, users can perceive the environment and objects in the virtual world and the objects and environment in the real world, thus realizing the deep integration of virtual and reality. For example, by embedding environmental sensors in virtual reality glasses, users can perceive the temperature, humidity, light, and other information in the real world and provide real-time feedback to the virtual world so that users can feel a more realistic virtual environment.

The interaction between virtual objects and natural objects in virtual reality environments is also more intelligently and flexibly controlled by IoT. In traditional virtual reality environments, users usually need to control the movement and operation of virtual objects through handheld controllers or keyboards and mice, which could be more intuitive and natural. With the introduction of IoT technology, users can control the movement and operation of virtual objects through voice recognition, gesture recognition, eye tracking, and other natural interaction methods, thus realizing a more intuitive and natural interaction experience(Xavier et al. et al., 2023). For example, users can control the movement and rotation of virtual objects through voice commands, control the size and shape of virtual objects through gesture recognition, and control the gaze point and focus of virtual objects through eye tracking, thus realizing more intelligent and flexible virtual reality interaction.

Data collection and analysis in virtual reality environments requires an efficient and accurate approach, and IoT technology can transmit data accurately in real time. In traditional virtual reality environments, users usually need to collect and analyze data by manually recording and analyzing data, which is inefficient and prone to errors(Zhao et al., 2023). With the introduction of IoT technology, users can collect and analyze data in real time through sensors and devices, enabling more efficient and accurate data collection and analysis. For example, users can monitor the user's physiological state in real-time by embedding biosensors in virtual reality glasses, and monitor the user's movement state in real-time by embedding motion sensors in virtual reality glasses, thus realizing more accurate data collection and analysis.

The combination of IoT technology and virtual reality technology brings people new application scenarios and experience methods. It provides more prosperous, innovative, and efficient support for a virtual reality environment's perception, interaction, and data analysis. The continuous development and popularization of IoT and virtual reality technology will show more extensive and in-depth application value in various fields such as entertainment, education, medical care, industry, etc., bringing more convenient, intelligent, and comfortable experiences to people's lives and work.

2.3 User Experience and Virtual Reality Painting

Virtual reality painting, as a new art form combining virtual reality technology and the art of painting, is characterized by a unique user experience. Compared with traditional painting methods, virtual reality painting provides users with a more immersive and interactive creative experience, enabling them to delve into the virtual world and interact and collaborate with the paintings(Sarker, 2021). In virtual reality painting, users can create paintings through hardware devices such as head-mounted displays, handheld controllers, and haptic feedback devices and utilize virtual brushes, paints, textures, and other tools to paint virtual paintings.

Virtual reality painting provides users with a more prosperous and more diverse creative space than traditional painting methods. In traditional painting methods, users usually need to rely on material materials such as paper, canvas, and paint to create paintings, which is limited by physical space and material restrictions, and the creative space is more limited. In virtual reality painting, users can create through any point in the virtual environment and use virtual brushes and paints to draw paintings of various shapes and colors, with a broader and more accessible creative space(Raimundo & Rosário, 2022). In traditional painting, users usually need to hold brushes and palettes to create paintings, which is limited by physical tools and materials, and the painting effect is more restricted(Sahoo et al., 2024). In virtual reality painting, users can use handheld controllers, touchscreens, and other interactive devices to create paintings, using virtual brushes and paints to draw all kinds of shapes and colors, and the painting effect is more intuitive and realistic. Users can benefit from virtual reality painting by having a more flexible and accessible way of creation. In traditional painting, users usually need to draw and paint by hand to create paintings, which is more tedious and time-consuming due to the limitations of manual skills and experience. In virtual reality painting, users can use handheld controllers and virtual brushes to create paintings, using virtual brushes and paints to draw paintings of various shapes and colors, making the creation process more flexible and accessible. In general, users usually need to perceive and appreciate paintings through vision and touch, which is limited by material and production process, and the art experience is relatively single and limited(Raimundo & Rosário, 2022). In virtual reality painting, users can perceive and appreciate paintings through visual and tactile senses, as well as perceive and appreciate paintings through various sensory channels such as hearing and movement, which makes the artistic experience more prosperous and more diversified.

3. Research methodology

3.1 Research Design and Architecture

The design of this study delves into an in-depth exploration of user experience and technological innovation in virtual reality environments for IoT paintings and a comprehensive assessment of them. In order to achieve this goal, this study adopts a systematic research design and architecture to ensure rigor and credibility.

3.1.1 Virtual Reality Painting Environment

When designing a virtual reality painting environment, the researcher decided to employ a range of specific hardware devices and software tools to ensure the user could have a high-quality virtual painting experience. Virtual reality glasses are the key device for users to enter the virtual world, and a high-resolution head-mounted display was chosen for this study to ensure that users could have a clear and realistic visual experience. In addition, a head tracking system is equipped to track the user's head movement and adjust the display content in time so that the user can have a realistic feeling of moving and observing in the virtual environment. As shown in Figure 1.

Figure 1 Virtual Reality Glasses

The handheld controller is the primary tool for users to create paintings. The controller is a precise and sensitive handle with multiple buttons and trackballs, which allows users to simulate natural brush movements and perform delicate painting operations. The handheld controller is also equipped with a touchpad and a gesture recognition function, allowing users to adjust the brush size, color, and stroke parameters through gestures to make the painting process more natural and smooth. As shown in Figure 2.

Figure 2 Handheld controller

In addition to virtual reality glasses and handheld controllers, haptic feedback devices are also equipped to enhance the user's sense of immersion and realism. These haptic feedback devices can simulate different tactile sensations and strengths, such as the texture of paper, the strokes of a paintbrush, and the application of paint. Users can use these haptic feedback devices to perceive and control the physical characteristics of the virtual painting process, thus making the painting experience more realistic and interesting.

In addition, to enrich users' drawing tools and materials, the study provides virtual brushes, paints, textures, and other drawing tools through which users can draw various shapes and colors to realize their creative imagination. These virtual painting tools have rich functions and parameters, which can be selected and adjusted by users according to their own needs and preferences, thus realizing personalized painting creation.

3.1.2 Virtual reality glasses

Adopting the eye-tracking method in virtual reality glasses to reflect the user's experience and feedback in the virtual reality painting environment is an effective means. By monitoring the user's eye movement trajectory and gaze point, the user's visual attention allocation and interest points in the virtual painting environment can be captured in real time, which can help understand the user's attention level and cognitive load on different painting elements.

Eye tracking technology can accurately determine the user's gaze point and gaze duration by tracking the user's eye movements, thus revealing the distribution of the user's visual attention in the virtual painting environment. By analyzing the user's eye movement data, it is possible to understand the user's attention level and priority to different parts of the painting and assess its attractiveness and visual effect. In a virtual reality painting environment, users may be confronted with many painting elements and details, such as colors, lines, textures, etc., in the picture. Through eye tracking technology, the distribution of the user's gaze points in the painting work can be analyzed to understand the user's attention level and interest in different painting elements and then assess the visual attractiveness and expressive effect of the painting work.

In addition, eye-tracking technology can also help assess users' cognitive load and cognitive process in the virtual painting environment. By analyzing the user's eye movement data, the author can understand the user's gaze path and the number of transfers in the painting work so as to infer the user's cognitive process and thinking activities during the painting creation process and assess his/her cognitive load and cognitive efficiency.

3.2 Experimental setup and data collection

A series of experiments were designed to collect and analyze relevant data to deeply study IoT product design for user experience and technological innovation in virtual reality environments. The experiment established a virtual reality painting environment consisting of a high-performance computer, virtual reality glasses, handheld controllers, haptic feedback devices, other hardware devices, and the corresponding virtual painting software. On this basis, 100 subjects were invited to participate in the experiment.

The experiment is divided into two main phases: an experiential phase and a data collection phase. In the experiential phase, subjects will enter the virtual reality painting environment and create paintings as the experimental design requires. They will be asked to use a handheld controller to draw in the virtual space while utilizing a haptic feedback device to feel the physical characteristics of the drawing process. During the process, subjects will freely express their creativity and ideas to complete a personalized virtual painting.

Various data were collected during the data collection phase to analyze the user experience and technological innovations. One of the data sources was the real-time recording of the subject's eye movement trajectories and gaze points through the eye tracking device in the virtual reality glasses to understand their attention allocation and points of interest during the drawing process. Biosensors were used to monitor the subject's physiological indicators, such as heart rate and skin resistance, to understand his or her physiological responses during the drawing process. Video and audio recordings were also synchronized to capture the subjects' behavioral performance and verbal feedback.

In addition to the above data collection methods, the experiment designed a follow-up questionnaire for the subjects to gain insight into their subjective feelings and opinions about the virtual painting experience. The questionnaire evaluated the drawing tools, interface design, operation fluency, haptic feedback effect, and suggestions for future improvement and development. The effects and impacts of IoT product design oriented towards user experience and technological innovation in virtual reality environments can be comprehensively assessed by comprehensively analyzing the experimental data and questionnaire results.

3.3 Data analysis methods

To gain an in-depth understanding of the effects of IoT product design oriented towards user experience and technological innovation in virtual reality environments, a variety of data analysis methods are used to process experimental data and draw conclusions. These methods include eye movement data analysis, physiological indicator data analysis, behavioral data analysis, questionnaire survey data analysis, etc. Using these methods, the effects and impacts of product design can be comprehensively and systematically assessed.

The sweep path analysis method was used to analyze eye movement data. Sweeping path analysis can help researchers understand the subjects' attention allocation and points of interest during the drawing process to assess the attractiveness and expressive effect of different drawing elements in the virtual drawing environment. Firstly, the density D of the gaze point was calculated with the equation:

$$\mathrm{D}=\frac{n}{A} \tag{1}$$

In equation (1), n is the number of gaze points, and A is the area of the drawing area. By calculating the distribution and duration of gaze points, it is possible to understand the degree and priority of subjects' attention to different drawing elements during the drawing process. In addition, cluster analysis was used to cluster the subjects' eye movement data into different visual behavior patterns. Then, heat map analysis was used to visualize these patterns for a more intuitive observation of the distribution of the subjects' visual attention.

A physiological response analysis was used to analyze physiological index data. Physiological response analysis can help researchers understand the subjects' emotional state and psychological stress level during the painting process to assess their emotional response to the virtual painting environment. The rate of change of heart rate HR and skin resistance GSR was calculated with the equation:

$$H=\frac{X_t-X_0}{X_0}\times 100\% \tag{2}$$

In Equation. (2), Xt is the value of the index at the moment of time t, and X_0 is the value of the index at the initial moment. By analyzing the rate of change of heart rate and skin resistance, it is possible to understand the emotional state and the level of psychological stress of the subjects in different painting stages.

In addition to eye movement and physiological indicator data, the study also processed and analyzed behavioral and questionnaire data. For the behavioral data, the study adopted the method of behavioral pattern analysis. Behavioral pattern analysis can help researchers understand the subjects' operational behaviors and feedback information during the drawing process to assess the ease of use and user satisfaction of the virtual drawing environment. The researchers used frequency analysis to compare the subjects' operating patterns and feedback information and factor analysis to analyze the reliability and validity of the questionnaire data. These methods allow for a comprehensive and systematic assessment of the effectiveness and impact of virtual drawing environments.

Through in-depth analysis of the experimental data, patterns, and trends can be identified to provide reference and guidance for further improvement and optimization of product design. Using a combination of multiple data analysis methods enables researchers to understand the effects and impacts of IoT product design geared toward user experience and technological innovation in virtual reality environments.

4. Results and discussion

4.1 Results of user experience survey

A user experience survey was conducted, and data were collected to gain a deeper understanding of users' experience and feedback in the virtual reality painting environment. The survey included eye movement data and evaluations of the drawing tool, interface design, smoothness of operation, and haptic feedback effect.

The eye movement data recorded by the eye tracking device provides insight into the subjects' visual behavior and attention allocation in the virtual drawing environment. The eye movement data are shown in Table 1 below.

Table 1 Eye Movement Data Sheet

norm	Average (sec)	Minimum (sec)	The maximum value (seconds)	Standard deviation (sec)
gaze duration	2.5	1.2	4.8	0.9
Number of viewpoints	50	30	80	10
Sweep path length	100	80	120	15

The average attention duration of the 100 subjects in the virtual painting environment was 2.5 seconds, the shortest was 1.2 seconds, and the longest was 4.8 seconds, with a standard deviation of 0.9 seconds. This indicates some differences in the subjects' attention durations to different drawing elements during the drawing process, but the overall level is moderate. The subjects' average number of gaze points in the virtual painting environment was 50, with a minimum of 30 and a maximum of 80, with a standard deviation of 10. This indicates some variation in the frequency and number of gaze points that the subjects were looking at during the drawing process, but overall, it was at a moderate level. The subjects' average sweep path length in the virtual drawing environment was 100 units, with a minimum of 80 units, a maximum of 120 units, and a standard deviation of 15. This indicates some differences in the subjects' eye movement trajectories during the drawing process, but overall, it shows a certain degree of regularity. By analyzing the eye movement data, it is possible to understand the subjects' visual behavior patterns and attention allocation in the virtual drawing environment. These data provide essential references and guidance for researchers to design and optimize virtual drawing environments, helping to improve user interface design and interaction experience and enhance user experience and satisfaction.

Table 2 below demonstrates the subjects' evaluation of the virtual painting tools. In evaluating the usefulness and functionality of various painting tools, most subjects were satisfied with the tools, such as virtual brushes, paints, and textures, and believed that they had a wealth of functions and parameters to meet their creative needs.

Table 2 Table of satisfaction level of drawing tools

Drawing Tools	Delighted (%)	Satisfaction (%)	General (%)	Dissatisfied (%)
virtual paintbrush	45	40	10	5
color	40	45	10	5
grain (in wood, etc.)	35	50	10	5

According to the data in Table 2, most of the subjects were satisfied with the virtual painting tools, with the virtual brushes and paints having the highest satisfaction, reaching 85% and 85%, respectively. This indicates that the virtual painting tools have rich functions and parameters that meet users' creative needs. However, a few subjects were dissatisfied with the practicality and functionality of the painting tools, which may be related to personal preference or usage habits.

Table 3 Satisfaction with interface design

interface design	Delighted (%)	Satisfaction (%)	General (%)	Dissatisfied (%)
Interface Layout	50	40	7	3
user interface	45	45	8	2

As shown in Table 3, most subjects were satisfied with the design of the virtual painting interface, and the interface layout and operation interface reached 90%. This indicates that the design of the virtual painting interface is reasonable, and the operation interface is straightforward to understand, which is conducive to users' quick start and free creation.

Table 4 shows how subjects rated the smoothness of the virtual painting operation.

Table 4 Satisfaction level of operation process

Smoothness of operation	Delighted (%)	Satisfaction (%)	General (%)	Dissatisfied (%)
Handheld Controller	55	35	7	3
haptic feedback	40	45	10	5

According to the data in Table 4, most of the subjects were satisfied with the smoothness of the virtual drawing operation, with the satisfaction level of the handheld controller reaching 90%. This indicates that the handheld controller's sensitivity and response speed are high, and it can meet the users' needs for fine drawing. However, a few subjects were dissatisfied with the smoothness of the operation due to the difference in operating feel or mastery level.

Table 5 shows the subjects' evaluation of the haptic feedback effect of virtual painting. Most subjects were satisfied with the haptic feedback effect. They believed that the haptic feedback device could simulate the feeling of actual painting and enhance their immersion and creative experience.

Table 5 Haptic feedback satisfaction level

Smoothness of operation	Delighted (%)	Satisfaction (%)	General (%)	Dissatisfied (%)

Smoothness of operation	Delighted (%)	Satisfaction (%)	General (%)	Dissatisfied (%)
Simulate the feeling of painting	50	40	7	3
immersion	45	45	8	2

4.2 Analysis of technological innovation and application effects

In this study, an IoT-based drawing system was designed in a virtual reality environment and combined with advanced technologies such as eye tracking for experimental verification. The effects of technological innovations and their application are analyzed and discussed below.

In this study, IoT technology is introduced into the design of the painting system, which enables remote control and data transmission by connecting the painting tools, controllers, and feedback devices to the Internet. This innovation allows users to create virtual paintings over the Internet anytime and anywhere without being limited by physical space and device location. For example, users can use the virtual painting system to create works at home and save them to the cloud or share them with other users, thus greatly expanding the space and possibilities of painting creation. This study incorporates eye-tracking technology to monitor the user's eye trajectory and gaze point in real time by embedding an eye-tracking device in virtual reality glasses. This innovation allows us to gain insight into the user's visual behavior and attention allocation during the drawing process. By analyzing the eye movement data, the author can understand the user's attention level, cognitive load, and painting strategy for different painting elements, thus providing essential references and guidance for product design and user experience optimization.

Regarding application effects, the virtual drawing environment designed in this study received positive evaluations and feedback from the subjects. According to the results of the user experience survey, most of the subjects were satisfied with the drawing tools, interface design, smoothness of operation, and haptic feedback effect, and they considered the virtual drawing system to have rich functions and a good user experience. This indicates that the introduction of IoT technology and the application of eye-tracking technology provide effective ways and methods for improving and optimizing the virtual painting environment.

Specifically, by applying IoT technology, users can achieve remote control and data transmission, realizing the convenience and flexibility of painting creation. Users can access painting tools and resources and perform virtual painting creations through the network anytime and anywhere, thus eliminating the limitations of time and space and enhancing the efficiency and convenience of painting creation. In addition, IoT technology provides a platform for users to communicate and share their works with others, which promotes artistic exchanges and cooperation and enriches the activities and contents of the painting community.

In terms of the application of eye tracking technology, it is possible to understand the user's visual behavior pattern and attention allocation during the drawing process by analyzing eye movement data. This provides essential references and guidance for product design and user interface optimization, helping to improve the interactivity and usability of virtual drawing environments and enhance user experience and satisfaction. By better understanding user needs and behaviors, virtual painting systems can be designed to match user habits and preferences better, thus enhancing product competitiveness and market value.

Products based on virtual reality and IoT technologies show great potential and innovation in painting. In other areas, virtual reality technology can also provide immersive experiences that make users feel like they are in a virtual world. This immersive experience can significantly enhance the user's sense of participation and emotional engagement, making the user more focused on the experience process and creating a deeper emotional connection to the product or service. At the same time, products based on IoT technology can be personalized, intelligently adjusted, and optimized according to user preferences and habits. For example, in virtual reality games, the game system can adjust the game difficulty and props settings according to the user's game behavior and feedback, thus providing a more personalized and intimate game experience. In addition, virtual reality and IoT technologies can realize more natural and intuitive user interaction, such as through gestures, eye movements, voice, etc. This type of interaction allows users to communicate and interact with the product more directly, improving user engagement and satisfaction. At the same time, the system can collect user feedback promptly and dynamically adjust and optimize according to the feedback, thus continuously improving the user experience.

5. Conclusion

The introduction of IoT technology allows users to create virtual paintings anytime and anywhere via the Internet, realizing the convenience and flexibility of painting creation. Users are not limited by physical space and device location and can access painting tools and resources via the Internet, thus enhancing the efficiency and convenience of painting creation. In addition, IoT technology provides a platform for users to communicate and share their works with others, which promotes artistic exchanges and cooperation and enriches the activities and contents of the painting community. Eye-tracking technology provides essential reference and guidance for optimizing product design and user experience. By analyzing eye movement data, researchers can understand users' visual behavior patterns and attention allocation during the painting process to design a virtual painting system that is more in line with users' habits and preferences. The application of eye-tracking technology enhances the interactivity and usability of products. It enriches the dimension of user experience, allowing users to express their creative intentions and emotions more freely. Virtual reality technology immerses users in the virtual world by simulating real-life scenarios, providing an immersive feeling. IoT technology, on the other hand, realizes a seamless connection with the natural world through intelligent devices and sensors, enabling users to feel the fusion of the natural and virtual worlds. This immersive experience can significantly enhance the user's sense of involvement and emotional engagement, allowing the user to focus more on the experience process and create a deeper emotional connection to the product or service. Virtual reality and IoT technologies play an essential role in the experience a product brings to the user, and their combination with each other can provide a richer, more immersive, and personalized user experience.

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