Smart Sensor Signal-Assisted Behavioral Model and Control of Live Interaction in Digital Media Art

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***Abstract*—Digital media art immersive scene design is a type of art design based on the theory of positive psychology mind flow theory, using digital media as the main technology and tool to build a certain scene by stimulating the senses and perception of the user so that they can achieve a state of immersion and forgetting other things. In this paper, we discuss the application of digital experience technology in designing art scene interaction devices by combining intelligent sensor signal analysis with multimodal interaction. Based on this, a new inductive displacement sensing element is proposed, which adopts square wave driving mode and op-amp circuit to extract signals, overcoming the shortcomings of the traditional inductive displacement sensing element, gaining the advantages of small size, lightweight, good linearity, high-frequency response, a simple driving circuit, and signal detection circuit, and more easily adaptable to microcomputer control. A more comprehensive anti-interference and system fault self-diagnosis design is carried out for the sensor system to ensure the stability and reliability of the system. An intelligent digital filtering algorithm with program judgment is proposed, with better smoothing ability and faster response speed. The multimodal interaction in digital experience design strategy is applied to the design practice, and a series of diversified device design solutions are proposed suitable for on-site interaction behavior.**

Keywords*—Intelligent sensors; digital media; VR technology; artistic interaction

I. Introduction

Under the development of art and culture globalization, the public's diversified needs for art and its dissemination are gradually growing rapidly. As a special position for the development of communication and art, art needs to meet the various needs of various audience groups. The value of art is mainly reflected in the artists' hard work, and the public's positive feedback on art and culture. It is imperative that the use of digital technology is no longer superficial and requires a more professional and rigorous attitude to regulate the use of new media technologies [1]. In the face of the rapid development of science and technology and digital media in the information age, cross-discipline, interdisciplinary, and cross-media have become mainstream topics in the study of art and technology and an indispensable part of the art development process. Artists and technology practitioners have become very interested in the integration of new technologies and new media [2], exploring new ideas and new problems that may arise from the union of art and technology, and making efforts to explore this. However, due to the late start of research on intelligent sensor systems for interactive behaviors in art scenes, their theory and practice are far from mature and far from practical application needs, especially the high-performance, small volume, and low-cost intelligent sensor systems for mechanical displacement measurement are yet to be further developed.

Based on the research on the structure and performance of traditional inductive displacement sensors and the theory and practice of intelligent sensor systems, this paper designs an intelligent displacement sensor system for live interaction of digital media art, which has the characteristics of small size, low cost, long life, large range, fast response speed, and high intelligence, etc., and obtains satisfactory results in practice. The design of digital art installations requires various technical means such as interactive visual technology, touch technology, physical interactive technology, code programming technology, and virtual/augmented reality technology to realize. In terms of infrastructure, improve the information technology and intelligent facilities and equipment of art and museums, establish the management information system of public cultural space, and improve the information level of infrastructure. In terms of experience, establish fun experience spaces that can interact with audiences, including setting up interactive cultural experience zones for books, paintings, seal engraving, etc., to enhance interactive tours and fun experiences in art and museums. With natural language processing techniques, it is possible to analyze the user's emotions in social media, text input, or voice interactions, and there is already a lot of research available [3]. Multimodal technology is widely applied to the various sensory experiences of art to the users through gestures, touch, gaze, and other forms of multimodal interaction to stimulate various perceptions and responses of art to the users and thus achieve a higher level of experience [4].

II. Related Work

Study [5] says for the user's own experience during multimodal interaction, multiple multimodal modalities with each other for information processing can bring a more efficient and better user experience to the user. Jiang N [6] suggests that the relationship between "immersive scene design" and digital media art is a shadow of one another and that immersive scene design in digital media art is not a new thing that emerged out of nowhere but has undergone a process from quantitative to qualitative change with the progress of technology and exploded in the present. Adams C [7] proposes the concept of "affective computing", which is a technology that deals with processing, recognizing, and imitating human emotions and feelings. A system with affective computing capabilities can gain insight into the user's emotional state and adjust various factors in human-computer interaction to positively affect the user. Tiwari P [8] explores the progress made in applying affective computing techniques to real-world problems involving human-computer interaction. He points out that effective computing must be developed as a user-centric technology to benefit the global digital economy. In the research [9], the perspectives and applications of emotion in HCI research are discussed in detail, a framework for effective HCI research is proposed, and related methods and techniques are categorized, thus opening up the field of HCI research on human-computer emotional interaction.

In addition, research has given recognition and attention to the application of AI technologies such as decision prediction, image recognition, pattern recognition, and voice interaction in museums, and many studies have explored the means of using AI and other technologies from the perspective of enhancing the overall experience of the audience. The research [10] uses intelligent agent (Agent) systems to assess the level of human-computer interaction through AI to enhance the user experience. By analyzing user interactions in the museum, better interactions and interactive exhibition modules can be designed. On the other hand, Rendell J [11] collects user data based on the viewer's mobile interface, which is used to build a personalized collection recommendation system that brings people and artifacts closer together. Colangelo D [12] points out the correlation between human-computer interaction and the development of artificial intelligence, puts them in a time dimension to sort out their development and evolution, and summarizes the characteristics of interaction design in the era of artificial intelligence. What you think is what you need, what you see is what you see, and what you see is what you get. In addition, under AI, human-computer interaction will break through the boundaries of the graphical user interface and turn its attention to the human emotion and consciousness space for context-aware, consciousness-aware, and emotion-aware computing. The author in [13] proposes three interaction modes: "passive, forced active, and active" between human and intelligent products, and analyzes the differences between them in terms of interaction starting point, initiative, data-driven and AI decision-making to improve the coherence and effectiveness of interaction and help users improve their efficiency and experience. Furthermore, [14] explores the industries and products empowered by machine learning, natural language processing, image processing, robotics, and other technologies in the era of artificial intelligence. Through the case study of smart water purifiers, the innovative, emotional, and information architecture optimization features embodied by the interaction design of artificial intelligence are pointed out. Similarly, [15] points out new ideas that need to be introduced for human-computer interaction-natural interaction, virtual reality technology for reality-based interaction, augmented reality, context-aware and affective computing, voice interaction, and multimodal interfaces as support. Wohn D Y [16] points out that effective computing is one of the foundations for establishing a harmonious human-computer environment. Since then, most of the research has focused on the field of computer science, trying to improve emotion recognition methods and enhance the accuracy rate by starting from expression, speech and physiological data, and multimodal fusion. Frenneaux R [17] thoroughly analyzed the current emotion models, facial expression interaction, speech signal emotion interaction, physical behavior emotion interaction, physiological signal emotion recognition, emotion extraction from text information and emotion intelligent agents, etc.

III. Design of Intelligent Sensor Signal-Assist System Based on Interactive Behavior in the Field

A. Intelligent Sensor System Design Scheme

One of the principles of digital experience design is that it is human-centred. Digital experience design provides a new interaction and expression for the user's experience, further stimulating deeper thinking of the user. Traditional measurement systems cannot store sensor-related information. They cannot be networked, which makes the system not have the function of intelligent identification of sensors and remote monitoring and has failed to meet the interactive behavior of art scene measurement requirements. With the development of modern information technology, intelligent networked measurement systems have come into being. The core technology of an intelligent networked measurement system is intelligent sensor technology, which is also the focus of this paper. Sensor technology, from the birth of the present, has gone through the "traditional sensor", "intelligent sensor", and "networked intelligent sensor" development stages [18]. Networked intelligent sensors of a wide range of different control network standards, access to each other inconvenient, so now the networked intelligent sensors are moving toward standardization.

This paper is designed based on the need for interactive behavior in the digital media art scene, using the intelligent sensor standard of IEEE1451.3. IEEE1451.3 establishes the standard for the interface between analog transmission networks and intelligently networked sensors. IEEE1451.4 establishes the standard for interconnection between intelligently networked sensors in a small space range. IEEE1451.5 establishes that IEEE1451.6 is about CANopen protocol transmitter network interface-related standards. IEEE1451.7 is about RF tag system transmitter communication protocol and transmitter electronic data form format-related standards. Fig. 1 below shows the framework of the standard protocol cluster used in this paper.

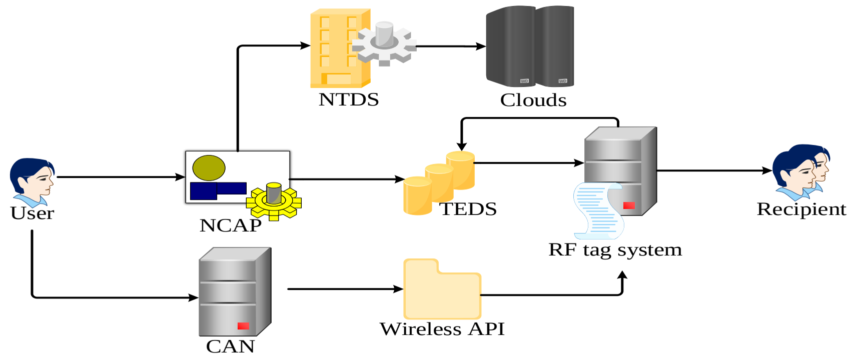

Fig. 1. Standard protocol framework.

The IEEE1451 standard separates the sensor node from the network implementation and is mainly divided into intelligent transmitter modules and network adapter modules. The different standards of IEEE1451.2-7 are used to define different communication protocols between intelligent transmitter modules and network adapter modules. The interface between intelligent transmitter modules and network adapter modules in the IEEE1451.2 standard is called Transmitter Independent Interface TII. The network adapter and intelligent transmitter modules have the same frequency and address arrays stored internally. The network adapter module sends the frequency and address numbers in the array to the intelligent transmitter module in binary form. ACK2 is set high if the element in the frequency and address number arrays is 1 and low if the element is 0. After the Intelligent Transmitter Module is connected to the Transmitter Independent Interface TII, it first communicates with the Network Adapter Module with three handshakes, then receives the binary numbers of frequency and address numbers from the Network Adapter Module, and converts the received binary numbers to decimal to find the corresponding frequency and address for its own IIC configuration [19]. Finally, the network adapter module will perform an IIC communication test with the intelligent transmitter. After the successful test, it will inform the upper computer software that the intelligent transmitter module is connected.

However, with the rapid development of the entire intelligent sensor processing platform and also as a class of typical entry systems, the entire intelligent sensor processing platform is becoming more and more complex, more and more functional requirements of the project, as well as the core microprocessor processing power continues to increase, the intelligent use of interrupts for functional switching of the front and back system defects are increasingly exposed. The first to emerge is a real-time multi-tasking kernel system; such operating systems can provide application programming interface API to the CPU and management of the microprocessor. With the progress of the sensor system intelligence requirements, system applications have become more complex, especially with the rise in communication needs, only the embedded operating system cannot meet. The embedded operating system gradually developed into a complete real-time multi-tasking, multi-functional operating system including file, network, development, and debugging environment, the application and development of IoT-related technologies, embedded OS, with a complete task (process), scheduling, memory management scheduling and other kernel functions, in addition to this also has the network and other functions of the service capability, reliability, real-time, scalable and reliability, real-time, cut and portability, etc. are also greatly developed [20]. Because of these features, embedded OS has become one of the decisive components of the smart sensor processing platform. freeRTOS is also in the field of smart sensor processing platforms today and occupies a rising rate of emerging RTOS, mainly characterized by small resource consumption, lightweight systems, short development cycles, ease of getting started, completely open-source free, and other features. Networked, especially sensor systems using wireless network technology, also make intelligent sensor processing platforms an important part of IoT devices. In sensor processing platforms that use wireless communication technology, the use of wireless technology enhances the maintainability of the platform. It is even cheaper because it saves costs such as wiring, and the competitiveness rises in the market. The application of wireless communication technology in the field of smart sensors makes up for many shortcomings of smart sensor processing platforms using traditional wired communication methods, breaking through some limitations such as physical environment restrictions on wiring, as well as not being easy to expand, higher costs, and other troubles. The use of wireless network technology in line with the application scenario can expand the smart sensor processing platform in the fields of medical health, environmental monitoring, consumer electronics, and other applications.

IV. Application of Intelligent Sensor Signal-Assist System in Digital Media Art Interaction

The development of digital experience equipment is a change in the traditional experience mode, it changed the traditional information transfer experience based on audio-visual, and through the use of technology to update the user to receive information and the use of products in the form of the user is no longer satisfied with the experience of a single sense, but more inclined to the "one plus one is greater than two" of the multimodal transport experience. The integration and superposition of multiple senses in the process of digital experience can fully mobilize the user's bodily functions, make the reception of information more interesting, and make the cognition of the experience more real [21]. Typical multimodal digital experience has virtual reality technology, which creates a virtual experience environment to give real cognition to the human brain. It can directly mobilize the integration of emotional modalities of participants through the basic elements of narrative design law, design, and creation of virtual scenes, real or virtual characters, engaging plot, immersive experience, and real atmosphere in the form of stories so that the experience is repeatedly between abstract and figurative. As a combination of art, technology, and media, digital media art immersive scenography belongs to spatio-temporal art if it is categorized according to the criteria of how the art form exists. The experience is repeatedly spanned between the abstract and the figurative, and feedback is given to the virtual environment through multimodal interaction to enhance the overall sensory experience and make it interesting and intuitive throughout the end of the digital experience.

Digital experience device design integrates a variety of media, including science and technology, experience design, aesthetics, etc. It integrates and restructures new art forms to enrich the expression of art. Through digital and multimedia technologies and forms to enhance the quality of the user's feelings in the experience, the interaction process can enable users to explore their thoughts and behaviors above the basic level of perception to achieve the purpose of integrating emotions and resonance. Digital experience devices can be roughly divided into six technical means, which are interactive visual technology, physical interactive technology, touch interactive technology, virtual augmented reality technology, mechanical interactive technology, and programming interactive technology [22]. Digital experience device provides new interaction and expression for the user's experience, further stimulates deeper user thinking, strengthens the perception of information, the pursuit of convenience and emotion, and makes the perception effect more towards the real feeling. Digital experience design is different from traditional installation design in that it requires not only the design of physical devices but also software support. The interactive characteristics of digital experience devices are different from traditional art devices and usually require interaction with people. Hardware is the basis for artists and designers to present their ideas, and no matter what kind of artistic expression is used, it should be carried by hardware technology. With the advent of the experience economy and the continuous development of sensory sensing, human body recognition, and tracking technologies, multimodal interaction is gradually used more frequently in creating digital experience design. Traditional physical experience devices have gradually been replaced by digital experience devices, giving users a multimodal interactive experience process consisting of multiple sensory elements that can receive multiple external communication messages and deeper emotional values. The corresponding design strategy is proposed in the design of the museum installation, and the design route of multimodal interaction in digital experience is shown in Fig. 2.

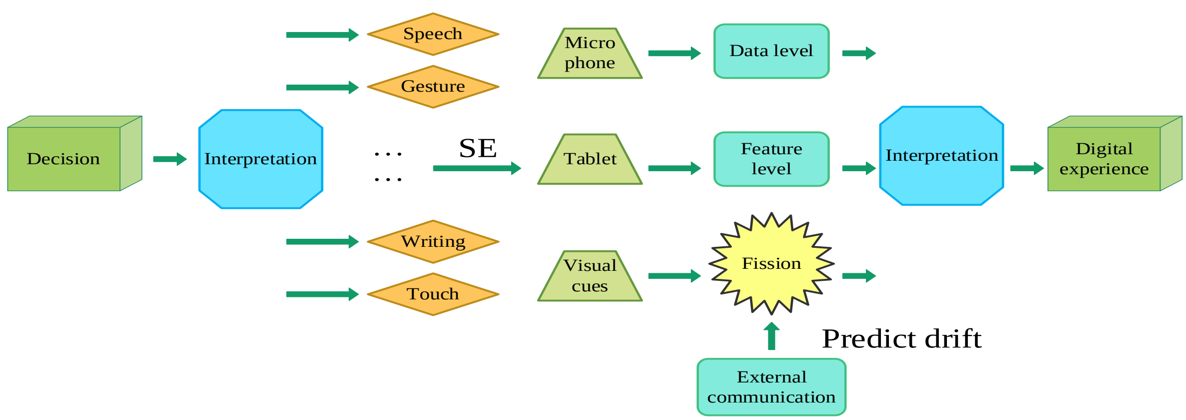

Fig. 2. Design routes for multimodal interaction in digital experiences.

The measurement structure of the capacitive pressure sensor is designed as a differential variable pitch type, consisting of a lower fixed pole plate and an upper half movable pole plate, where the lower pole plate is a silicon substrate covered with a metal oxide film and the upper pole plate is a metal pole plate with a measurement cavity in the middle. The cavity change causes a capacitance change, and the measurement electrode and the driving electrode are led from the two pole plates, respectively. The advantage of using a differential structure is that when the sensor is a non-differential structure, the capacitance value of the capacitor of electrification ($\tau = 1$)is

$$\eta = -\mu \sum_{t-1}^{n} K_{ij}\, \Omega_{ij} - K\left|M_{\bar{ij}}\right| \tag{1}$$

When the pole plate is actuated, the plate gap change capacitance is changed $C_y\,(z)$, i.e.:

$$C_y\,(z) - C_\mu . \int A.M(x)M(z)dxdz + C_{x0} \tag{2}$$

Then for non-differential structures, the sensitivity is C_y:

$$C_y = C_\mu . \int A.M(x)dx \tag{3}$$

Its nonlinear error b is approximated by:

$$b = (O_k - T_k) \cdot g(k) \tag{4}$$

The comparison shows that using a two-pole differential capacitance sensor is twice as sensitive as a single-pole capacitance sensor and greatly reduces the nonlinear error of the sensor. In addition, the structure also reduces the influence of electrostatic force between the poles and effectively improves the interference caused by environmental factors such as temperature. When the mechanical structure enters the microscopic level, many phenomena that are ignored at the macroscopic level can become factors that cause instability in the mechanical structure at the microscopic level [23]. For many MEMS devices, the phenomenon of electrostatic absorption is well worth studying. Currently, "workable objects > dynamic visualization > non-workable objects > picture-based static visualization > graphical static visualization > text", from what can be touched to what can be seen in the order of human sensory contact, too abstract, is not popular. Processing involvement and intervention can help users achieve the purpose of human-computer interaction and improve people's experience when they are in contact with digital experience devices. The electrostatic suction phenomenon is the disruption of the dynamic equilibrium of the system when the applied voltage reaches a certain value for the dynamic and fixed poles, and the two poles are sucked together. On the one hand, the existence of the electrostatic suction phenomenon causes instability in measurement. On the other hand, the use of electrostatic force generated by the charge distribution on the pole plates to drive micro devices is also an important research direction.

The control system of the art installation is divided into four modules, including respectively information acquisition module, an information transmission module, a central control module, and a media presentation module, which together build the whole interactive system of the digital art installation and only by combining these four parts can the complete interactive process of the digital art installation be completed. There are many types of information acquisition modules, including simple touch acquisition, sound acquisition, image acquisition, etc., to more complex behavior acquisition, expression acquisition, and other modules. The information transmission module plays a role in the whole digital art installation; when the information acquisition module detects the information, including touch, image, sound, action, etc., it transmits to the central control module through the transmission module, the central control module is also the core part of the whole art installation. It is also the computer's control system, which calculates, processes, and uses the data and programs and then gives them to the media presentation module through the information transmission module. The media presentation module presents the final artistic effect through the media presentation module. The final effect of the media presentation module directly determines the artistic effect of the installation. Using the presentation form of digital media technology can mobilize a variety of senses for the experience, such as using a touch screen to mobilize the sense of touch, allowing the experience to integrate into the art installation or even become part of the installation.

V. A Technological Approach to Digital Experience in Multimodality

Digital experience device design integrates a variety of media, including science and technology, experience design, aesthetics, etc. It integrates and reorganizes new art forms to enrich the expression of art. Through digital and multimedia technologies and forms to enhance the quality of the user's feelings in the experience, the interaction process can make the user explore their thoughts and behaviors above the basic level of perception, to achieve the purpose of integrating emotions and resonance. Digital experience devices can be roughly divided into six technical means, which are interactive visual technology, physical interactive technology, touch interactive technology, virtual augmented reality technology, mechanical interactive technology, and programming interactive technology [24]. The digital experience device provides new interaction and expression for the user's experience, further stimulates the user to think more deeply, strengthens the human perception of information, the pursuit of convenience and emotionality, and makes the perception effect more towards the real feeling. In emotion computing, the computer does not measure emotions directly. Still, it extracts emotional data by observing external representations of emotions and performs a pattern recognition to infer the current emotional state. Therefore, emotion recognition can be understood as "establishing a mapping relationship between emotional characteristics data and internal emotional states". With the development of augmented reality, mixed reality, and artificial intelligence technology, the future development trend of intelligent sensor-assisted digital media interaction will also be combined and updated with iterations. Emotion modeling is to build a mathematical model to classify and quantify human emotions and then train the model a lot through the emotion database so that the model can recognize various emotions more accurately, so it is the key to emotion recognition.

Interactive cultural creation provides a way of thinking about cultural creation innovation. By integrating cultural and historical knowledge into digital and gamified carriers, users can be inspired by culture through interactive experiences. By injecting the concept of "interactive", we can broaden the form and carrier of cultural creation, change the purpose and thinking of cultural creation development, and upgrade the cultural creation experience, ultimately driving the disruptive innovation of museum cultural creation. The relationship and differences between interactive and traditional cultural creation are shown in Fig. 3

Under the trend of "technology +" and "AI +", the practice of interactive cultural and creative design in museums has taken shape. As a form of cultural creation that focuses on experience, emotional interaction under artificial intelligence is based on the ability to understand and respond to emotional data in interaction, which can precisely give deeper meaning to the cultural creation experience with emotion, thus reflecting the full necessity. Secondly, emotional interaction can gain insight into users' interests, adjust their state, and eliminate frustration; the interactive experience under AI embodies multimodality and initiative and generates natural and real feelings, thus providing more opportunities and possibilities for the interaction design of cultural creation. Through interactive and emotional creative works, the CMA hopes to target the general public with less experience in art appreciation, eliminating their intimidation when facing obscure artworks. An audience survey that examined whether interactive artworks in museums increased engagement showed that 76% of people felt they enhanced their overall museum experience. In comparison, 74% felt it encouraged them to look more closely at the artwork, and those who experienced interactive artworks reported being more willing to delve into cultural history and learn more.

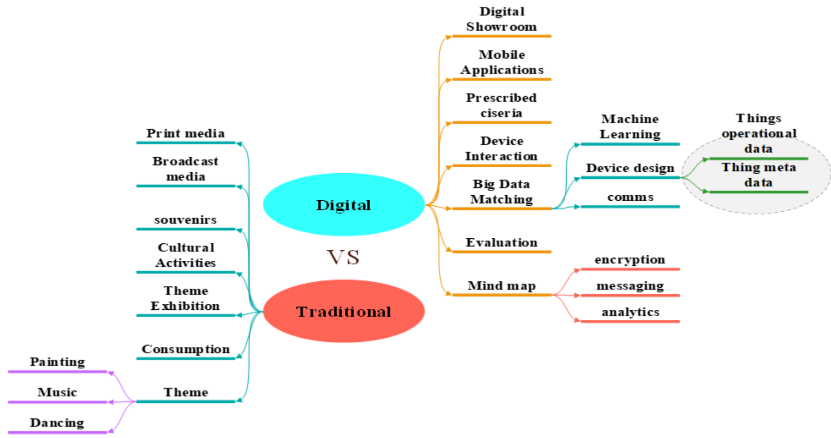

Fig. 3. Relationship and differences between interactive and traditional culture and creativity.

Emotional interaction is the system's mindfulness of human emotions, i.e., the system's mode of understanding human emotions. Emotion computing is the use of artificial intelligence mathematics to calculate human emotions. However, before that, it still requires designers to "specify" emotions in two ways: establishing emotion dimensions and defining key emotions. Establishing an emotion dimension is to describe emotions in a multidimensional and quantitative way [25]. The role of emotion models in emotion recognition is divided into discrete models, dimensional models, and others. The dimensional model can be referred to in emotional interaction design to establish the design dimensions of emotion recognition in performance. Among them, the most recognized and widely used model is the valence-arousal model, based on which the PAD model consisting of pleasure-arousal-dominance is proposed.

Key emotions are scene-related, descriptive words for emotional states, which can be used as typical emotions for emotion recognition and expression of key features. In the emotional interaction design of literature and creativity, first, establish a thesaurus of key emotions; then filter by the degree of emotional granularity (i.e., the degree of detail and complexity of key emotions needed for emotional identification and emotional expression), the greater the granularity, the more specific and clear the description of emotions, and vice versa, the vaguer; it can be described as follows.

$$F(e) = \cup\, \omega^{e} \cdot [K\chi + R\eta]^{-1} \tag{5}$$

Finally, the emotional interaction process is designed based on the key emotions and the stimuli required for emotional expression.

$$F(\gamma) = \sqrt{a^2 + b^2} \cdot c\varpi + \kappa\gamma^{d} \tag{6}$$

In practical design, key emotions and emotional dimensions can be used in combination. By mapping key emotions to quadrants composed of multiple emotional dimensions, we can ensure that various emotional states are covered and also facilitate cooperation and communication between designers and developers. Emotional interaction is a new kind of interactive experience, which is very different from the graphical interaction interface represented by smartphones in terms of input and output modalities and elements and the form of emotion recognition and expression. Secondly, the emotional interaction system has artificial intelligence's decision-making and feedback capability. It involves natural interaction modes, such as gestural interaction, somatic interaction, and even brainwave-intentional interaction [26]. Therefore, the factors mentioned above should be reflected in the emotional interaction interface so that emotional acquisition and recognition can be easily perceived and emotional intervention and expression can be easily understood by people.

VI. EXPERIMENTAL VERIFICATION

A. *Smart Sensor Calibration Experiment*

Using the least-squares method to process the data, the choice of the highest power of the fitted equation also has a significant effect on the accuracy of the pressure sensor. The fitting algorithm was written using Matlab to process the positive and negative travel data of the sensor to generate fitting equations with the highest power of two, three, and four, respectively, and the correlation coefficient of the fitted curve R2, which is the degree of similarity between the fitted curve and the actual curve. According to the comparison results, the fitted correlation coefficients are very similar for the highest power of three and four, while the second power fails to meet the requirements. Considering the difficulty of data processing, the highest power of the fitted equation was finally chosen to be three times, and the fitting error was analyzed according to this fitted equation, according to Eq. 7.

$$\mathrm{L} = \sum_{(i,j,k)\in D} -\ln \sigma(z_{ij} - z_{ik}) \tag{7}$$

The fitting error of the measured data was calculated using Matlab to obtain the fitting error curve in Fig. 4.

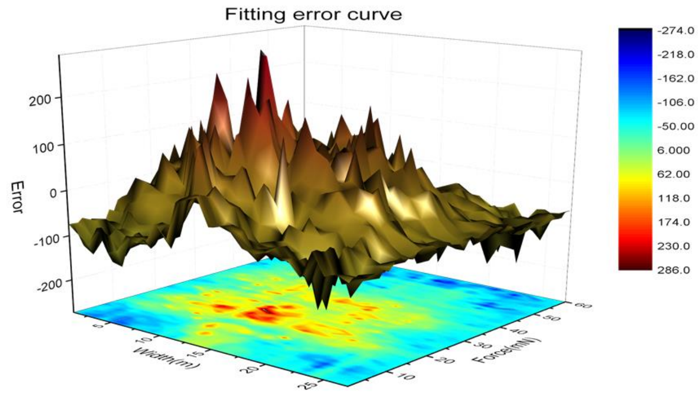

Fig. 4. Fitting error curve.

The resolution is the smallest input signal increment that the sensor is more capable of sensing or monitoring. When the system is running, the sensor to be measured is adjusted to any position after the system is stabilized, and the data from the sensor to be measured is obtained over some time. The installation and measurement process of the smart electrostatic actuated capacitive force sensor is a multi-system fusion installation and measurement process, which theoretically requires a highly stable installation and operating environment. In practice, due to the test conditions, the test bench installation conditions are rudimentary, and the operation process is highly susceptible to vibration, which affects the measurement results and usually takes the form of discarding the data from the previous section. In addition, if there is a deviation in the connection between the sensor to be measured and the displacement element, it will also lead to the elastic deformation of the components, causing abnormal sensor output data. The error is usually reduced by taking the average of multiple data to avoid this situation. Various factors cause noise in the system, and it is also difficult to eliminate, including power quality, component noise, switching noise, system integration of different functional modules cross noise, space magnetic field, capacitance measurement of the noise introduced by the discharge to ground, and the noise in line with the principle of reducing the noise so that it does not affect the measurement results. A filtering circuit is used for each module of the board, the sensor and circuit board are grounded with a metal case, and a twisted shield is used for the key lines to reduce the noise impact of the above factors. Fig. 5 shows the resolution sampling after correction.

When curve-fitting the sensor output data, the fitted curve does not completely represent the real data, and there is always a certain amount of error present. To reduce the fitting error, the spacing of the collected data is reduced, and the method of fitting higher power terms is improved. In the experiments, fitting polynomials of the highest power three are used to meet the data fitting requirements. The absolute and differential pressure sensors are tested using a portable pressure calibrator. To perform the pressure test, the sensor is connected to the calibrator through a conduit, and the pressure inside it is changed by adjusting the knob of the pressure meter, which in turn leads to changing the pressure value at the detection end of the sensor. Since the interval residual can be regarded as a time-varying detection threshold, the proposed interval residual-based detection algorithm can further address the limitations of the residual evaluation function and a priori threshold in signal processing-based detection methods. Calculating each sensor value can be used as a basis to determine whether the sensor is working properly. Since each sensor value is less than the control limit, the calibration coefficient can be calculated directly using the multiple regression fusion algorithms. Then the data fusion calculation formula is used to calculate Wan. The focus is on the data processing of each sensor. For the sensor, the comparison of the controller display data with the experimentally processed data through simulation resulted in the results shown in Fig. 6.

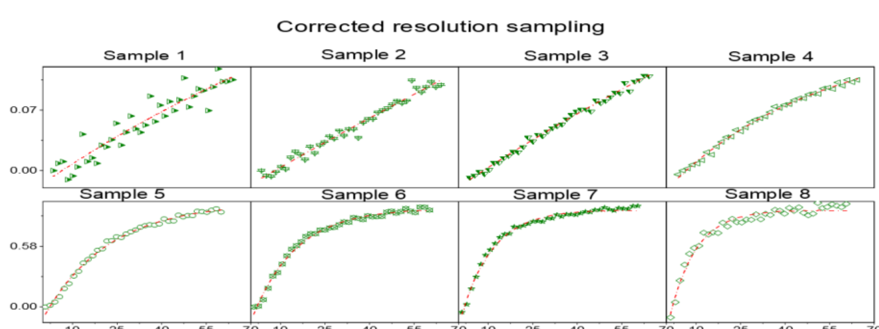

Fig. 5. Corrected resolution sampling.

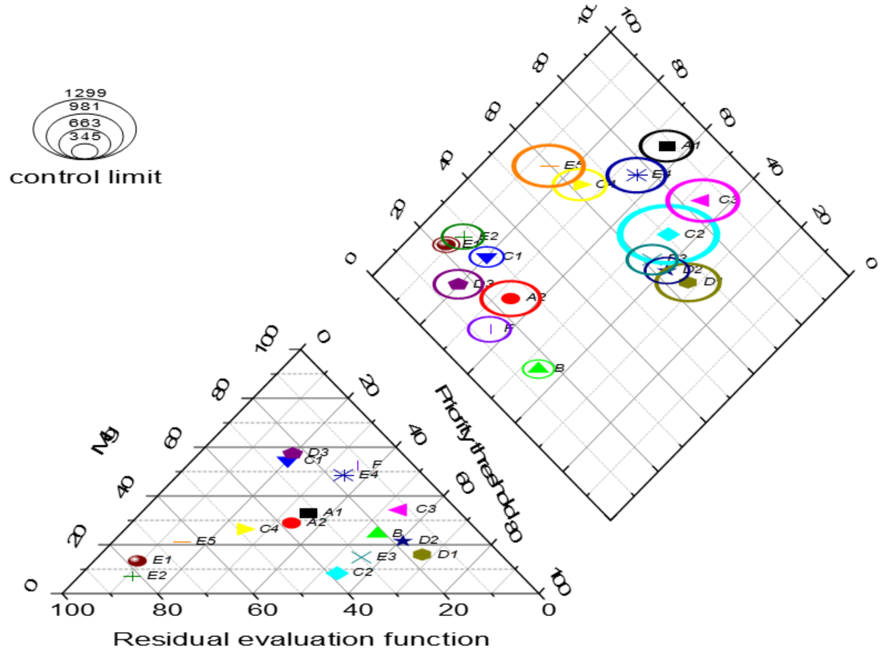

Fig. 6. Sensor residual modulation image.

All components of the common platform should be modularized, including all hardware and software, should use the modular design idea to realize the platform can add or delete components and ensure the least change to other components, mainly to facilitate the secondary developers to be able to customize and tailor the hardware and software according to the actual needs.

B. Smart Sensor-based Digital Media Art Application Field Test

Compared with the traditional design method of creative arts, the intelligent creative arts design implementation process embodies many advantages: First, based on the information collection, opinion analysis, and audience insight capabilities of intelligent sensors, it can more precisely and efficiently locate the emotional interactive creative arts user group, draw a user profile of them, and define the creative arts functions according to the needs and preferences of users. Subsequently, the intelligent design process provides designers with many practical tools. For example, relying on the data brought by museum visitors, AI can help designers filter elements suitable for cultural and creative design from a large number of art resources, which not only makes design elements and design results more in line with users' interests and expectations but also helps expose users to cultural and museum content beyond art exhibits and exhibitions; furthermore, using AI for the content generation to reduce repetitive workload and improve design development efficiency. Based on pattern recognition, AI can evaluate design prototypes and design results, thus becoming a rapid testing tool. In addition, obtaining users' emotional feedback through emotional interactive literature can, in turn, further validate the design and make improvements in the iteration and serialization of the design. Fig. 7 shows the correlation analysis between emotional performance and interaction behavior.

Fig. 8 shows the construction of the emotional space in which the basic emotions are located. The analysis of the actual data shows that the most dominant affective expressions in affective expressions of the enriched interaction behavior model are positive and agreeable, and the negative and agreeable affective states rarely appear and have no effect on collaboration satisfaction and can be neglected. Therefore, this section focuses on the effect of positive and agreeable effective expressions on collaboration satisfaction in the realistic interaction behavior model. The unstandardized coefficient of the frequency of positive and negative affective performance of the independent variable was 78, significant 18, less than 5, and the constant 86.267, significant 0.000, less than 0.05. The coefficients and constants of the independent variables were significant, using the frequency of positive and negative affective performance as the independent variable for the linear regression of collaboration satisfaction. Emotional interactive creative design by building a library of emotional expression elements so that the system can call all kinds of elements freely according to the results of emotional decision-making. Secondly, by setting the key emotion and emotional dimensions, the intensity and duration of emotional expression of the output elements can be controlled; the scene model is defined to evaluate the effect and impact of the output table elements on the user in that round, and then the emotional interaction system can be adjusted in real-time to ensure that the emotional expression makes the user feel comfortable and natural.

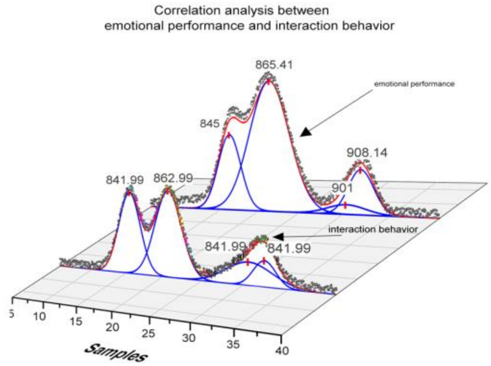

Fig. 7. Correlation analysis between emotional performance and interaction behavior.

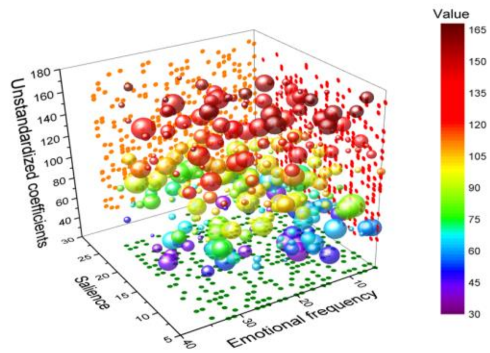

Fig. 8. Construction of emotional space in which basic emotions are located.

VII. Conclusion

In terms of theory, the user's feeling consists of multiple sensory elements that can stimulate more profound emotional values during the multimodal interaction experience of receiving multiple externally communicated information. In this paper, according to the multimodal interaction experience process, combined with intelligent sensor signal assistance, the multimodal experience hierarchy in digital experience design is divided into three aspects: basic perception, behavior exploration, and thinking connection. The attack detection and separation method based on state observer is proposed from the cybernetic perspective. The design products are designed from three aspects, including the dynamic physical characteristics of the system, residual evaluation function, a priori threshold design, attack separation under structural vulnerability, etc. The design results include the design of a screen device under basic sensing, the design of a seating device under behavioral interaction, and the design of live interactive behavior of digital media art under thinking connection, the three stages are progressive, further stimulating the user to think more deeply. The three stages are designed to stimulate the deeper thinking of the user and to build emotional resonance so that the user can finally understand the designer's ideas and integrate his understanding of the digital experience. Therefore, the design research on the emotional experience of mobile tour system users also needs to be adjusted according to the current development trend. Relevant design strategies also need to be based on the characteristics of cutting-edge digital media forms, targeted adaptation and output of "technology integration" of user interaction experience digital solutions.

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