Intelligence and Emotion Application Framework in Interactive Art Design

Yihang Bo
Fine Art Department
Beijing Film Academy
Beijing China
boyihang@bfa.edu.cn

Zuqiang Yi
Fine Art Department
Beijing Film Academy
Beijing China
yizuqiang@bfa.edu.cn

Xi Chen
Fine Art Department
Beijing Film Academy
Beijing China
chenxi@bfa.edu.cn

***Abstract*—The integration of technology and art has brought different vitality to the development of contemporary art, and meanwhile, it has injected fresh blood into the interactive art design. The integration makes the interactive art develop towards a more intelligent and humanized direction, thus enhancing the immersion and integration sense of the interactive artworks. This paper proposes a framework of how to apply artificial intelligence and artificial emotion method in interactive art design. And we test the application of artificial intelligence and artificial emotion in interactive art through an interactive artwork.**

Keywords- Interactive Art, Artificial Intelligence, Hybrid-augmented Intelligence, Artificial Emotion, Affective Computing

I. INTRODUCTION

Artificial intelligence (AI) [1] is not a fresh topic. With the coming of the era of AI and the rapid development and maturity of AI technology, many researchers pay attention to artificial emotion [2] in line with the principle of "people-oriented". In addition, the concept of AI art [3][4][5][6] and AI aesthetics[7][8] has also entered the vision field of art as AI is widely integrated into all aspects of our social life. From AI to man-machine cooperative hybrid-augmented intelligence [9], from AI art and AI aesthetics to hybrid-augmented intelligence art and hybrid-augmented intelligence aesthetics, from artificial intelligence to artificial emotion, what kind of qualitative innovation will take place in interactive art design under the combination of "intelligence" and "emotion"? And what kind of vibrancy and excitement will bring to interactive art design in future? The framework of this paper is shown in Fig.1. There are 3 parts: Interactive art, "intelligence" in interactive art design and "emotion" in interactive art design. The first part explains what is interactive art and the embodiment of it. The second and third part discuss how to use artificial intelligence and artificial emotion methods in interactive art design.

.

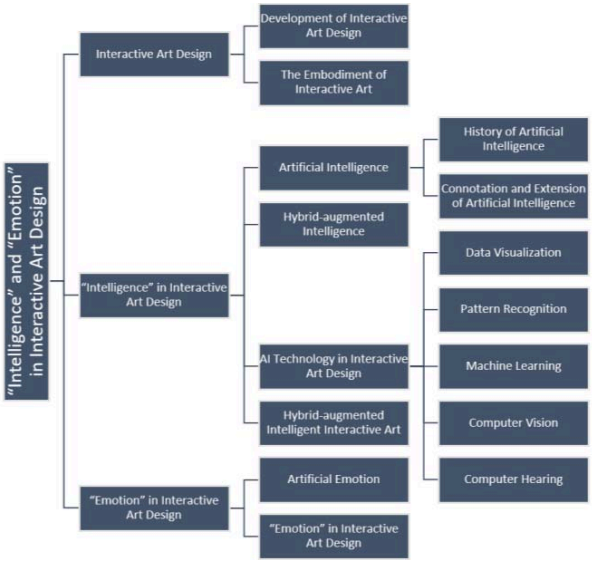

Fig.1 The framework of this paper

II. INTERACTIVE ART DESIGN

The scope of "interaction" is quite extensive. It exists between persons, between person and object, or between objects, while it cannot be called "interaction" if only input or output exists. For interactive art [10], let's start with the nature of interaction. We could sum up as three categories: interactive art of human behavior, interactive art between person and machine and interactive art between different objects. What we talk about in this paper is the interactive art between person and computer, which belongs to the second category.

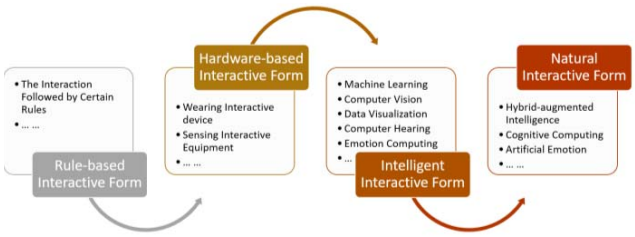

Fig.2 Development of interactive art design

978-1-7281-8915-4/20/$31.00 ©2020 IEEE
DOI 10.1109/QRS-C51114.2020.00067

A. Development of Interactive Art

Interactive art is not a strange concept for us, which is the inevitable product of the development of contemporary art to a certain stage. The emergence of interactive art innovates the appreciation form of traditional artwork, closers the distance between audience and artwork, and integrates the audience and artwork as well. The audience could be a part of the artwork, meanwhile he/she could also be one of the creators of the artwork.

People-oriented is not only the core of artificial intelligence aesthetics, but also the fundamental starting point of interactive art. In interactive art design, people are the first factor to be considered. Scan the development process of interactive forms in interactive art, as shown Fig.2, it has experienced rule-based interaction, hardware-based interaction, intelligent interaction and future natural interaction. Early interactive artworks mainly rely on some rules or prescriptive actions in advance, namely rule-based interactive form. The creator always put the rules and steps in a salient position in the artwork, and the audiences experience and complete the interaction with the work according to these rules and steps when they appreciate it. Because the rules are designed in advance, the whole interaction process will be relatively smooth and fluent. Although the interactive works in this form enhance the audience's participation and immersion sense, these established rules make the interaction between audience and artwork become too rigid and stylized, which also reduce the interest of the artwork. In other words, it is not humanized. Of course, because the interaction process in this mode is relatively smooth and not easy to be abnormal, it has been loved by many artists and has been used up to now.

With the continuous progress of hardware technology, artists began to create utilizing some wearable interactive devices. Compared with rule-based interactive design, this interactive form no longer requires rigid interactive rules and steps. As long as the audience wears these sensing devices, they could interact with the artwork, and the participation form becomes more free and flexible. However, although this data transmission form is relatively smooth, timely and less delay, these wearing devices, such as heavy headwear equipment, induction gloves, induction vest, etc., will make the audience feel less comfortable when participating in the interaction, which will affect the aesthetic feeling of the whole artwork invisibly. It is also the reason why creators do not favor this form of interaction.

The appearance of somatosensory hardware equipment improves the current situation that it is necessary to wear sensing equipment. The audience does not need to interact according to the established rules and steps, nor need to wear any sensing equipment to be integrated with artworks. It is greatly improved the degree of flexibility and humanization and also enhanced the sense of immersion. However, this kind of somatosensory device, such as gesture sensor leap motion, human body infrared camera Kinect, and the position sensor Real Sensor, will be affected and limited by the sensing range. The audience must be within its sensing range when they interact with the artwork. In addition, since the delay or omission of the sensing hardware receiving data, the interaction process will also be delayed or missed, then reducing the interactivity and immersion of the artwork.

Different forms of interaction have their own advantages and disadvantages. It could not perfectly meet the needs and requirements of the audience and also puts forward higher requirements for interaction technology. The integration of artificial intelligence technology has brought new possibilities to the promotion of interaction form and interaction process, which makes the interactive artwork develop in the direction of more intelligent, natural and humanized. Computer vision, speech recognition, machine learning and other AI methods enable the interaction to be completed smoothly without any rules and interactive hardware. The human-computer collaboration hybrid-augmented intelligence integrates human emotion, cognition and inspiration into the interaction process, which provides strong technical support for the development of interactive art towards a more natural and human-oriented direction. Artificial emotion makes the interaction process more and more humanitarian, and brings more fresh blood into the interactive art.

B. The Embodiment of Interactive Art

According to the definition of Dautenhahnd Odgen, "Embodiment" [11][12] means if there is an interference channel between the two, then system S is in environment E. In other words, the mutual interference between system S and environment E, that is, when system S and environment E exist at the same time, S has the ability to disturb the state of S in E, while E has the ability to disturb the state of E in some subsets in the possible state of S relative to E.

Body is the medium of all perception, it is a sense organ, so it must participate in all perception. Generally speaking, the body is the bridge between the self and the outside world. People perceive the outside world through the body, and the outside world also understands and recognizes us through our body. In the book "The Phenomenology of Perception" [13], Merleau Ponty from French put forward the philosophy of "embodiment". He advocated that the subject of perception is body, the body is embedded in the external world, just like the heart is embedded in the body. Cognition, body and environment constitute a unified organism. From the perspective of embodiment, the body is equivalent to system S, and the external world is equivalent to environment E. The mutual interference between the two is the mutual communication and cognition between the body and the external world. Therefore, body is also the core soul of interactive art design.

In interactive art design (here we refer to human-computer interaction art), as the main body of interaction, people complete the interaction in the process of mutual cognition and communication with artworks (external environment), that is, the so-called embodied cognition. The relationship between physical experience and mental state promote each other. Human body plays an important role in it. The cognitive process between people and artwork is the main content to research in interactive art design. Additionally, emotion is also one of the indispensable elements of embodiment, and the generation, development and change of emotion are also

important factors, which affect the interaction process. This paper will discuss the cognitive and emotional problems involved in the interaction process from two aspects of "intelligence" and "emotion" in interactive art design.

III. THE "INTELLIGENCE" IN INTERACTIVE ART DESIGN

A. Artificial Intelligence

a) History of Artificial Intelligence

Artificial intelligence (AI) is not a fresh object, which was born in 1950s. Turing, the father of computer and artificial intelligence, first broke the boundary of the time and put forward "Turing test" in 1950. Dartmouth conference marked the birth of artificial intelligence in 1956. Rosenblatt proposed perceptron neural network in 1957. After then, Samuel first proposed and created the concept of "machine learning", and began to let computer have the ability of learning as people. At that time, limited by the computing power of computers, AI once entered a cold winter. Until 1997, Deep Blue of IBM defeated the chess champion. AI began to develop in a stable direction. Recent years, the development of Internet technology not only accelerated the innovation research of AI, but also made it move forwards the direction of practicality. In 2006, Hinton proposed neural network of deep learning, which enabled the computer to simulate the way of thinking of human brain for learning. And by 2013, deep learning had made significant breakthroughs in speech, vision, natural language recognition and other aspects, which got an extremely high recognition rate. In 2016, Alpha Go developed by deep mind team defeated the game of go champion with deep leaning algorithm. Now a days, with the rapid development of big data, cloud computing and other technologies, the application scope and field of AI technology are more and more extensive.

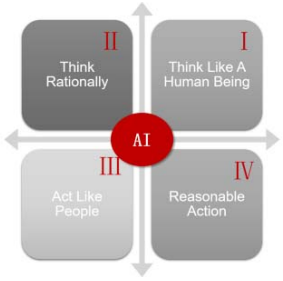

Fig.3 4-dimensions of artificial intelligence

b) Connotation and Extension of Artificial Intelligence

AI experts divide AI into 4 categories and 8 definitions, also named as 4 dimensions of AI [1], as shown in Fig.3. The first category of AI can "think like a human being", in other words, AI is a machine with a human brain. The second category of AI can "think rationally", that is, AI could study intelligence by using computational models. The third category refers to the technology that machine can "act like people", that is, create machines that can perform some functions. And when people perform these functions, they do need intelligence. The fourth category is called "reasonable action", which refers to the design of intelligent agent in the research of computational intelligence. In the 4 dimensions, the definitions of the first and second dimensions focus on the process of thinking and reasoning, while the definitions of the third and the fourth dimensions emphasize behavior; The definitions of the first and the third dimensions are mainly based on the fidelity of the machine and human thinking or action to determine whether it is successful, while the definitions of the second and the fourth dimensions are based on whether it meets a reasonable and ideal standard to determine whether it is successful.

There are many subjects covered by AI. According to the summary of "AI Development Report 2019", AI mainly involves machine learning, computer vision, knowledge engineering, natural language processing, speech recognition, computer graphics, multimedia technology, human-computer interaction technology, robot, database technology, visualization technology, data mining, information retrieval and recommendation and other disciplines.

Compared with human intelligence, the research field of AI is still in the stage from "have" to "have", that is, on the basis of existing objects, it recombines a new object according to certain rules. While human intelligence could not only from "have" to "have", but also from "none" to "have". In other words, People could create new object without any existing foundation but their own experience.

There are also AI experts who divide AI into 2 stages: weak AI and strong AI [1]. For weak AI, it seems to be intelligent, but in fact, it just completes a specific task according to some established requirements, and does not have the real ability of self-reasoning and self-solving problems. From the perspective of computer, data, algorithm and program are the core elements of AI. However, algorithm is not equal to human inspiration, and program is also not equal to human ideology. Thinking and creativity in strong AI could not be separated from human ideology and inspiration. Machine cannot create artwork like artist without consciousness and inspiration. And the works of art are no longer artworks without consciousness. Obviously, the current AI is still in the stage of weak AI.

B. Hybrid-Augmented Intelligence

Recent years, many fields have undergone subversive changes with the rapid development of AI technology. Intelligent machines can complete some repetitive and productive work independently. Nevertheless, AI technology is only limited to simulate human intelligence. Machine is still at a loss what to do for the creative work, which needs human emotion, inspiration and creativity, such as art creation. Therefore, how to integrate human inspiration and artistic creation ability into AI technology is very important for our artistic creation [15].

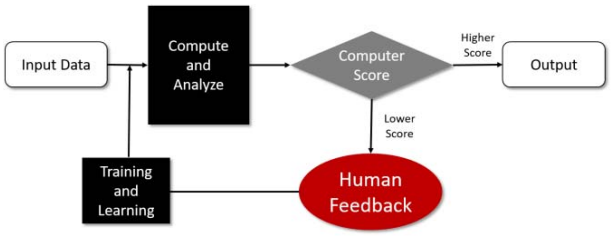

Fig.4 Hybrid-augmented intelligence

The human-computer cooperation hybrid-augmented intelligence [9] has become a typical feature of the new generation of AI, and the interaction and hybrid work between human and intelligent machine has gradually become a new working form. That is to say, it is possible and necessary to introduce human role or cognitive model into AI system to form a hybrid augmented intelligence form. This form could be divided into 2 basic forms: human in loop augmented intelligence and cognitive computing based hybrid-augmented intelligence. Among them, human in loop hybrid-augmented intelligence refers to a kind of intelligent system that requires people to participate in the interaction, as shown in Fig.4. As a part of this system, when the output decision score is relatively low, it will form a feedback loop to improve the intelligence level. This form could combine human perception and cognitive ability with computer's powerful computing and storage ability, thus forming an intelligent augmented form of "1+1>2" [14]. The cognitive computing based hybrid augmented intelligence refers to the intelligent software or hardware that improves the perception, reasoning and decision-making ability of computer by imitating human brain functions, so as to build an intelligent computing model more accurately, especially the new computing framework of cause model, intuitive reasoning and associative memory. At micro, macro and real-time levels, we study human-computer hybrid-augmented intelligence to realize the symbiosis, co-evolution and mutual augmented of human intelligence and machine intelligence, so as to achieve the augmented and compensation of human motion ability, perception ability and cognitive ability by AI.

C. *AI Technology Applied in Interactive Art Design*

a) *Data Visualization*

No matter what kind of interactive language or form, data visualization [16] is one of the essential technical methods in interactive art design. Meanwhile, data visualization is also one of the important branches of AI technology. How to express various data forms, such as visual data, sound data, tactile data and emotional data, etc., in the form of vision is quite important in interactive artworks design. For example, in artwork "Pitchpaint" as shown in Fig.5, the sound signal is transformed into lines with different thickness, direction and length according to the height of sound and the change of audio, that is, the sound signal is displayed in various visual forms.

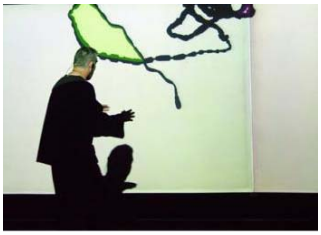

Fig.5 Interactive artwork "Pitchpaint"

Specifically speaking, for data visualization, we are not only required to have the basis of data statistics and data mining, but also to have the ability of image graphics design and information knowledge visualization. There are 5 processing steps: data acquisition, data analysis, data table description, data modification and data interaction. In interactive art design, data acquisition may come from 2 different sources, one is the existing data information on hard disk or network, and the other is the real-time data information received or generated in interactive process. In addition, the acquired data could be visual, auditory, or various abstract data types such as emotion, cognition, etc. In other words, the acquired data types are related to the interaction mode, and different interaction modes input different types of interaction data. In data analysis stage, we could further analyze the acquired data, extract meaningful and useless data, and choose a suitable expression way to express the analyzed data. For instance, we could choose tree chart, ring chart, pie chart, list and other different visual forms, and even use the generation art forms, such as fractal art, to create more diverse and beautiful data expression forms. Data modification is particularly important, which is also the key step to improve visual expression effect. For example, we could modify and adjust the color, brightness, texture, shape and other attributes of visual elements, so as to make the image more colorful. This step is also closely related to the aesthetic judgment of art creators.

b) *Pattern Recognition*

Pattern recognition [17] is common in our daily life. For example, when we see a dog and a bird, we could distinguish which one is dog and which one is bird quickly. The reason is quite simple. Based on the previous understanding of dog and bird, we will have a dog template and a bird template in our brain. For example, the dog has four legs, beard, tail and other features, while bird has two legs, two wings and other features different from dog. When we see a dog, we will naturally match this dog with the dog template in our brain, and consider it as a dog if the matching is successful.

Fig.6 Hand gesture mask examples

The so-called "pattern" is actually an abstract concept, which is an abstract template formed by extracting the features of a certain kind of objects. "Recognition" could also be understood as classification according to the matching degree with the template. In computer science field, pattern recognition refers to the automatic pattern processing and discrimination by computer through mathematical methods. It has important and effective applications in computer vision, speech recognition, natural language processing, brain like intelligence and other relative fields.

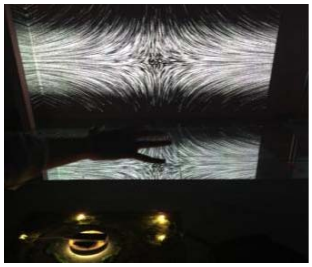

Fig.7 Hand gesture recognition in interactive artwork "Touch" by Di Yang

We could see pattern recognition everywhere in our interactive art design. For example, hand gesture recognition, as shown in Fig.6. The contour of each gesture has its different distribution structure with different feature points. If it is successful when computer matches the input gesture with the gesture template in database, it will trigger interactive feedback. Fig.7 shows an example created by student Di Yang from Beijing Film Academy. It uses two kinds of hand gestures including five fingers and fist to control the divergence and aggregation of the universal particles. Of course, we could select different types of hand gestures to trigger different response events in our interactive art design.

Similarly, face recognition, pose recognition, heart rate recognition and so on are all follow the same principles. And these interactive bridges are often applied on our interactive art design.

c) Machine Learning

Whether it is visual interaction form, or hearing and emotion interaction form, machine learning is the necessary method to make machine understand the participants, that is, to make the machine have the ability of learning and imitating.

When we mentioned AI, we have to mention machine learning [17], which is the key and important way to solve the problem of AI. AI cannot be separated from the learning process and the ability of machine learning. There is a more authoritative definition of machine learning:" A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P, if its performance at tasks in T, as measure by P, improves with experience E. ——by Tom Mitchell（A Professor at the Carnegie Mellon University (CMU)）" [18]. That is to say, machine learning is actually a computer program, which aims at a task T. If the performance measurement P in the task is improved, then we can learn the experience E from it.

Computers constantly update and modify the corresponding judgment or calculation methods through learning. It can be roughly divided into the following common forms according to the way of learning: supervised learning, unsupervised learning and semi-supervised learning. Deep learning [19] is a very popular machine learning method in recent years, which is come of artificial neural network. From the perspective of cognitive psychology, the cognitive process of human brain is from low level to high level, from concrete to abstract level by level. That is, human brain is a multi-layer and deep structure framework. From the biological view, human brain is composed of countless nerve cells; each neuron is connected with other neurons, thus forming a complex network structure. Artificial neural network is formed by simulating the neural network structure of human brain. At present, deep learning method has been widely used in many fields of AI, such as image / video detection, classification and recognition, image / video generation, speech recognition, machine translation, natural language processing, etc., all of which have been beyond the previous calculation results, especially in the calculation accuracy, it shows its unique advantages and is loved by everyone.

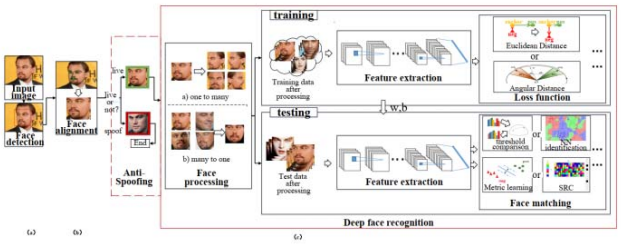

Fig.8 Deep face recognition system [26]

For instance, face recognition is also a common technology in interactive art design. Face recognition using deep learning method [26], as shown in Fig.8, could give us a more fluent and accurate interactive signals during the interactive process. After face is located and aligned, it uses different architectures and loss functions to extract discriminative deep features, and uses these features to classify the faces. While, there is still very few interactive artworks using machine learning methods now, but it would be an essential way in interactive designing when the interaction is more and more intelligent.

d) Computer Vision

As an important branch and component of AI, Computer Vision (CV) [20] is a subject that studies how to make computers have the ability of "seeing", "recognizing" and "thinking" like human being. It is a kind of computer simulation of biological vision, and also the basis of machine understanding and cognition of the world. Its ultimate goal is to let the computer "see" the world. Computer Vision was born as early as 1960s, which originated in the colleges and universities researched on AI. The emergence of CV is mainly to make machines have intelligent visual behavior like human beings by simulating human visual system. The problem CV focuses on is to simulate the human visual processing system so that the computer could solve problems that human visual system could solve. Since then, computers, like human beings, have their own visual system.

Psychological research shows that, for human beings, the vast majority of information received from the outside world comes from the visual system. For computer, visual information also occupies a very large proportion in many input information, and its position is also extremely important. In interactive art design, all kinds of cameras for obtaining visual information are like human eyes, while computer are like human brains, which process the visual information from the outside world. For example, face detection is a quite common method in CV. The camera gets visual information from the outside, and the computer could find the face in the video based on the features of human face. Fig.9 gives us an example of interactive artwork created by Danyang Wang, a student from Beijing Film Academy. It detects whether there are someone walk into the closed space, and the interrupt of the person will cause the virtual baby's uneasiness.

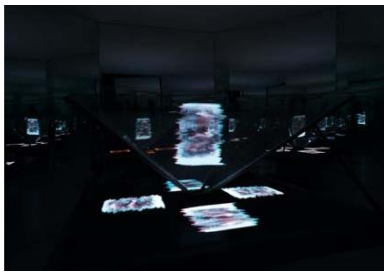

Fig.9 Interactive artwork example of Danyang Wang

e) Computer Hearing

Similar to CV, computer hearing [21] is the ability for a computer to have the ability of hearing. In interactive art design, it mainly involves 2 aspects: sound detection and sound recognition. Give a very simple example, the common voice control lamp in our daily life actually belongs to this kind of interactive form. As long as the sound sensor detects a certain loudness of sound, it will trigger the switch to turn on the lamp. At this time, the sound signal is just like the switch of the lamp. Of course, in most interactive artworks, sound and other forms of perception often coexist and work together, rarely exist alone. With the development of sound processing technology, the interaction form of sound is more and more diverse, natural and intelligent. The computer can not only detect the existence and disappearance of sound, the level of sound, but also recognize the category and content of sound. It then makes the interactive artworks more fantastic. In Fig.10, it is a student interactive artwork created by Bi Han from Beijing Film Academy. In this artwork, reading different words could produce different illustrations. Computer can recognize which word you read.

Fig.10 Interactive artwork example of Bi Han

D. Hybrid-augmented Intelligent Interactive Art

In recent years, with the rapid development of AI technology, many fields have undergone subversive changes. With the aid of AI, intelligent machines could complete some repetitive and productive work independently. At present time, AI is only confined to simulate human intelligence, which makes machines have certain imitation ability. However, machines art still at a loss for human emotion, inspiration and creative work, such as art creation. Therefore, how to integrate human inspiration and artistic creation ability into artificial intelligence technology is quite important for our artistic creation.

The hybrid-augmented intelligence of human-computer cooperation has become a typical feature of the new generation of AI, and the interaction and hybrid work between human and intelligent machine has gradually become a new form. In other words, it is necessary to introduce human's role or cognitive model into AI system to form a hybrid-augmented intelligence form.

Hybrid-augmented intelligence includes human-in-loop hybrid-augmented intelligence, brain-computer cooperation human-computer intelligent symbiosis, machine intuitive reasoning and causal model, cognitive computing framework and many other tasks and key technologies. These technologies are intended to combine the cognitive ability of human beings with the massive storage and fast computing ability of machines, which is essential to improve the artistry of AI art. Among them, cognitive computing framework enables computer to imitate the perception, reasoning and decision-making ability of human brain and change passive learning into active learning. The human-computer cooperative hybrid-augmented intelligence makes human intelligence and machine intelligence complement and promote for each other through the integration of biological intelligence of human brain and machine intelligence. So that art works not only retain the characteristics of AI art, but also make artists' creative inspiration and creative experience to the maximum extent.

The advantage of hybrid-augmented intelligence in art creation is especially reflected in interactive art. In addition to integrate artist's inspiration in creation process, the audience could also integrate their cognition and inspiration into the artwork during the interaction with it. The degree of intelligence and humanity of the interaction will continue to improve with the interaction process between audience and artworks. Specifically speaking, the original interactive artworks only feedback various information received from audience directly in the form of vision or hearing. It will not make any improvement or change for the interactive process. The interactive art based on hybrid-augmented intelligence mentioned here could not only directly or indirectly feedback the input of audience, but also learn the abstract information knowledge such as emotion, cognition and inspiration provided by the audience. It will make the artwork to have the ability of self-adaptation and recreation. With the increase of interaction with the artworks, the artworks themselves will continue to undergo qualitative changes.

IV. THE "EMOTION" IN INTERACTIVE ART

A. Artificial Emotion

AI tries to make machine owner and simulate human intelligence. However, it seems that only simulating could not meet the requirements and needs of people more and more. How to make machine have human emotion, produce emotion, recognize emotion and express emotion is a fresh development of AI. Artificial emotion (AE) simulates human emotional intelligence, including psychology, brain science, anthropology, cognitive science, computer science, informatics, AI and other

disciplines. Based on these subjects, AE simulates the generation, recognition and expression of emotion by means of computer and information science, so that machines could have human like emotion.

There are 3 main components of emotion, including physiological arousal, subjective experience and external performance. Subjective experience is the emotional individual's self-perception of various emotional states. According to the central nervous process theory of emotion, emotional response requires the brain to play a role in input stimulation and output response. While, external expression refers to the movement form of all parts of the body when emotional state occurs, such as mood, heartbeat, expression, posture change, etc.. AE simulates these three components and give them to the machine itself.

Affective computing [22] is one of the main research fields of AE. Emotion computing makes computer have the ability of emotion like people and become more and more vivid. The robot is still cold and merciless only with artificial intelligence. Emotion computing could make it warm and meaningful like human beings. Professor Picard first proposed affective computing in the media lab of MIT. And the research of affective computing largely depends on the latest progress of cognitive science and psychology on human intelligence and emotion. From the view of psychological, emotion is a kind of relationship between people and environment. When the objective environment is consistent with our needs, it will cause positive emotional reactions. On the contrary, it will cause our negative emotional reactions. Baogang Hu, a researcher of CAS automation, pointed out that the purpose of affective computing is to establish a harmonious human-computer environment by giving computers the ability of recognition, understanding, expression and adaption to our emotions, and make computer have higher and comprehensive intelligence [23]. Computer obtains various human emotional information through different external devices, such as expression, posture, voice, heart rate, etc., and classifies, recognizes, analyzes and responds to the information. In other words, it allows the computer to "observe the speech, observe the color", "feel the cold and warm", which slows down people's strangeness and frustration when they interact with the computer.

B. "Emotion" Applied in Interactive Art Design

In interactive art design, emotional information directly impacts the effect and trend of intelligent interactive design, which makes the form of interaction more substantial, harmonious, natural and humanized. Computers could enhance people's sense of kindness to works and enhance the distance between people and works through the acquisition, recognition, analysis and feedback of human emotions.

In brief, the affective computing in interactive art design usually includes 3 main steps: emotion feature extraction, emotion feature recognition and classification, and emotion expression. For emotion feature extraction, there are many methods to express people's emotion, such as facial expression, voice tone, body movement, etc., also, it can judge people's heart rate, body temperature and muscle movement with some instruments. Therefore, expression, intonation, movement, heart rate and other data information can be used as the basic characteristics of our calculation of human emotions. For human emotion recognition, it is difficult to accurately judge a person's emotional state only through a certain feature. Generally, we could consider different types of emotional features to identify and judge emotions, that is, multimodal patterns. Among them, visual presentation is the most common and intuitive.

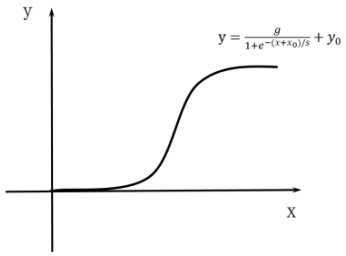

Fig.11 S-type nonlinear function curve

An S-type nonlinear function is proposed to describe the effect of various stimulus signals on mood, which is used to describe a variety of natural phenomena, as shown in Eq.1.

$$y = \frac{g}{1+e^{-(x+x_0)/s}} + y_0 \qquad (1)$$

Where, x is the input, which represents possible stimulus signals. It may come from the outside or inside the body. y represent the height of the curve. If x is extremely small, y will be 0. Or else, if x is unlimited increase, y will reach a maximum, as shown in Fig.11. Here, s controls the slope of the dome, and g controls the amplitude of the curve. The shape of the curve will be effected by the input stimulus signals and also the mood of the person.

From the perspective of image emotion theory, visual form is easy to cause and express emotional features. Influenced by the features of color, texture, shape and content, these visual features will directly stimulate the visual nervous system and pass to cerebral cortex through visual nervous system. People process and recognize the information according to long-term visual experience and cognition, and activate people's various psychological states and emotional changes. In interactive art design, the emotional information received is feedback to people in the form of vision, so as to further stimulate people's emotional response to interact with the artwork.

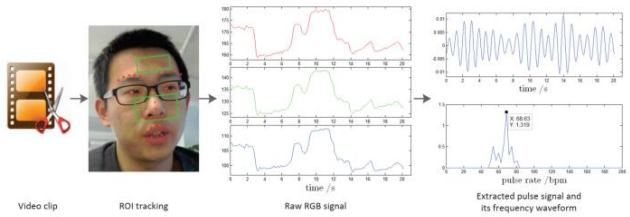

Fig.12 Method of real time non-contact pulse estimation [25]

We did a simple emotional interaction experiment in interactive art design. In our experiment, we used both external performance and internal physiological response to detect the

change of human emotions. For external performance, we selected facial expression [24], which is the most intuitive expression of human emotions. For internal physiological response, we used a video based method of real time non-contact pulse estimation [25]. As shown in Fig.12, it used a robust tracking method to locate a patch of skin on human face, and employed a chrominance-based algorithm to extract pulse signals. For the stimulus signals, we adopted the music with distinct rhythm, which could easily cause a change of human mood. And the magnitude of the changes would cause the distortion of the virtual animal image, as the example shown in Fig.13.

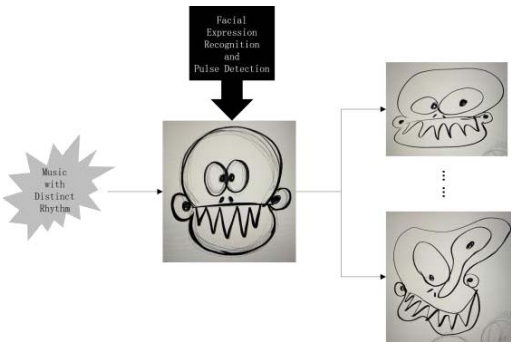

Fig.13 Experiment diagrammatic sketch

Undoubtedly, the integration of emotion could make the interactive process more humanized, can guide and control the whole interaction process more naturally, and can shorten the distance between people and artworks invisible, which is also the development trend of interaction art in the future.

V. CONCLUSION

Today, science and art are more and more closely combined. The continuous improvement of artists' artistic creation level puts forward higher requirements for science and technology, and promotes the progress of science and technology. On the contrary, the development and progress of science and technology also brings fresh blood and passion to artistic creation. Throughout the development process of interactive art, the innovation and change brought by science and technology are permeated all the time. After a long winter, AI reappears in front of people. With the development of various technologies, our interactive art creation is also developing towards more and more intelligent and humanized. In the future, hybrid-augmented intelligent art will appear as a new form of art creation, and open a new chapter for art creation. Especially for the interactive art creation, the perceptual cognition of human is integrated into the interactive design to break through the traditional interactive mode and make the immersive interactive process more natural, intelligent and humanized. The innovation and promotion of art design cannot be separated from the progress of science and technology. The progress and development of science and technology also provide a new possibility and development direction for the process and form of art creation.

As the interaction between human and the outside world, we also interact through various forms of perception in our interactive art design. Artificial intelligence methods help us to simulate human intelligent perception and artificial emotion stimulate human emotion generation and recognition to make the interactive process more intelligent and humanized. So as to enhance the immersion and interaction of the artworks. And how to apply artificial intelligence and artificial emotion methods in interactive art design will become more urgent.

REFERENCES

[1] J. Russell, Stuart, "Artificial Intelligence: A Modern Approach". People's post and Telecommunications Press, 2002.

[2] "Artificial emotion". Industrial Engineer: IE, 2009.

[3] B. Marr, "What is AI Art?", bernardmarr.com, 2019.

[4] T. Fevrier, "Le Scandal de l'Intelligence Artificielle.",Medium(website)(in French), January 28,2020.

[5] G. Cohn, "AI Art at Christie's Sells for $432,500", New York Times, May 21, 2019.

[6] G. Cohn, "Up for Bid, AI Art Signed 'Algorithm'", New York Times, May 21, 2019.

[7] F. Tao, "How Can Artificial Intelligence Aesthetics be Possible?". Literature and Art Contending, 2018, No.286(05):80-87.

[8] F. Tao，"Creativity and emotion: a preliminary study of artificial intelligence Aesthetics". Chinese Book Review, 2018, 000(007):26-34.

[9] N. N. Zheng, Z. Y. Liu, P. J. Ren, "Hybrid-augmented intelligence: collaboration and cognition". Frontiers of Information Technology & Electronic Engineering, 2017, 18(2):153-179.

[10] N. Stern, "Interactive Art", A Companion to Digital Art. John Wiley & Sons, Ltd, 2016.

[11] B. Robins, K. Dautenhahn, P. Dickerson, "Embodiment and Cognitive Learning – Can a Humanoid Robot Help Children with Autism to Learn about Tactile Social Behaviour?". Social Robotics. Springer Berlin Heidelberg, 2012.

[12] R. Rupert, "Review Essay: R Gibbs: Embodiment and Cognitive Science". 2006.

[13] M. Merleau-Ponty, "Phenomenology of perception". Routledge, 2012-1-9.

[14] Y. H. Pan, "AI trend 2.0". Engineering(4):6, 2016.

[15] N. N. Zheng, "What is the Next Step in AI?". China Education Network（12）: 40,2016.

[16] Telea, Alexandru, "Data Visualization". 2007.

[17] C. M. Bishop, "Pattern Recognition and Machine Learning (Information Science and Statistics)". Springer-Verlag New York, Inc. 2006.

[18] R. Hierons, "Machine learning". Mitchell. Published by McGraw-Hill, Maidenhead, U.K. International Student Edition, 1997.

[19] Y. Lecun, Y. Bengio, G. Hinton, "Deep learning". nature, 2015, 521(7553):436.

[20] Stockman, C. George, "Computer vision". Prentice Hall, 2001.

[21] Schroeder, R. Manfred, "Computer speech. Recognition, compression, synthesis". 2nd. Springer-Verlag New York, Inc. 2004.

[22] W. Picard, "Affective computing". MIT Press, 1997.

[23] B. G. Hu, T. N. Tan, J. Wang, "Affective Computing: A New Subject in the Development of Computer Science and Technology". Science Times, 2000.

[24] https://github.com/WuJie1010/Facial-Expression-Recognition.Pytorch

[25] B. Peng, W. Wang, J. Dong and T. N. Tan, "Detection of computer generated faces in videos based on pulse signal", 2015 IEEE China Summit and International Conference on Signal and Information Processing (ChinaSIP), Chengdu, 2015.7.12-2015.7.15.

[26] M. Wang, and W. Deng . "Deep Face Recognition: A Survey." arXiv (2018)