A Methodological Approach to Create Interactive Art in Artificial Intelligence

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Abstract. In recent years, with the rapid development of big data, cloud computing, and deep learning, artificial intelligence (AI) has returned to the public's field of vision once again and gradually deepened and infiltrated into different areas of our life. In this context, interactive art faces the unprecedented opportunities and challenges. In the past, the process and results of interaction were under the control of the creators, and the audience could only interact with artworks mechanically. Most of these interactive artworks just met the primary demand for the audio-visual effects and the sensory stimulation, which has become a common problem of interactive art. However, developments of AI in the field of human-computer interaction allow artists to go beyond the limitations of the past, thus the interactive process will be more human, intelligent, and diversified. AI involved in artistic creation is undoubtedly the developing trend and the latest direction of future. Nevertheless, interactive art in AI, whose creative mechanism has not been constructed, just begun to rise, and requires theoretical guidance. Therefore, discussing and studying the interactive art creation mechanism in the context of AI will have certain theoretical, practical and social significance. The purpose of this paper is to provide a methodological approach for interactive art creation in the context of AI, and a new creative thinking and direction for art practitioners, theoreticians and scientists. This paper first discusses the core role of AI media in interactive art creation. And then it analyzes the subjectivity and interrelationship between the artists, robots and participants in the process. Finally, it puts forward the basic idea of constructing a new mechanic system of intelligent interactive art creation. In short, this paper builds a new interactive art creation system that takes "cognition of human-computer symbiosis, innovation supported by intelligent technology, collaboration among creative subjects, and constraints on creative behavior "as a new methodological approach, in which AI is the core media, artists, robots, and audience are the co-creation subjects.

Keywords: Artificial Intelligence (AI) · Interactive Art · Intelligent Medium · Multi-subjects · Creation Mechanism

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1 Introduction

Nowadays, AI technology is developing rapidly and gradually penetrating into various fields, whose purpose is to explore the limits and the methods of using digital computers to imitate, extend and expand functions carried out by the human brain, such as obtaining and dealing information through the senses, understanding natural languages and solving complex problems [1]. In this background, AI has begun to march into the realm of art. Both artists and scientists have showed great interest in application of AI in artistic creation. On the one hand, scientists hope that AI will learn the deepest and most complex emotions of human beings, which is a multi-channel way of expression, and make machines closer to human beings with more friendly, sensitive, and aesthetic capabilities. On the other hand, as the innovator of the era, artists have also tried to train AI to discover its artistic expressions and ideas. AI, as a branch and category of computer science and technology, seems to have an inextricable relationship with interactive art since its birth. Interactive art is a participation-focus art form based on computer technology, sensor technology, and human-computer interaction technology, which will presumably use AI as the core media and efficient tools for creation in the context of AI. As a result, many interactive artists have been already eager to apply AI technologies into interactive art creation.

Turning to the specific context of interactive art and the unique way of using kinds of AI technologies, there are several situations that could describe the relationship between AI, artist, artwork, viewer, and environment. We have envisaged three categories that are characterized by the different roles AI plays in the process of interaction and the different situations, which are defined as: *dynamic-passive*, *interactive-indirect*, *and interactive-direct*.

Dynamic-Passive: The first is that AI acts as a behind-the-scenes worker in the work of art. That is, the creative mechanism inside the work is mainly determined by the artists, who inputs a great amount of data to train AI to generate a series of text and images, which are presented as the content of the art object. Moreover, AI have no relationship with the behavior of the audience who is a passive observer of this activity. The "flyAI" produced by American artist David Bowen can fall into this category. This installation artwork uses the machine learning image recognition library on the open source platform TensorFlow to allow AI systems to learn to distinguish the images of houseflies. When houseflies fly and land in front of the camera, their images are captured by the computer, and then the image recognition software will classify the captured images and rank the recognition results from one to five according to the percentage of possibility based on how likely the software thinks the listed item is what it sees. If "fly" is ranked number one on the list, there will be a mechanical pump that supplies water and nutrients to the houseflies. Other than that, the machine will not respond. The system is set up to run indefinitely with an indeterminate outcome, which remind viewers of the future destiny of mankind (see Fig. 1).

Interactive-Indirect: In addition to all of the features of the dynamic-passive category mentioned above except passive observers, there is an extra factor that the audience has an active role in influencing the changes in the art object, but the interaction between AI and audience is indirect. For instance, Turkish artist Seluk Artut created an AI-based

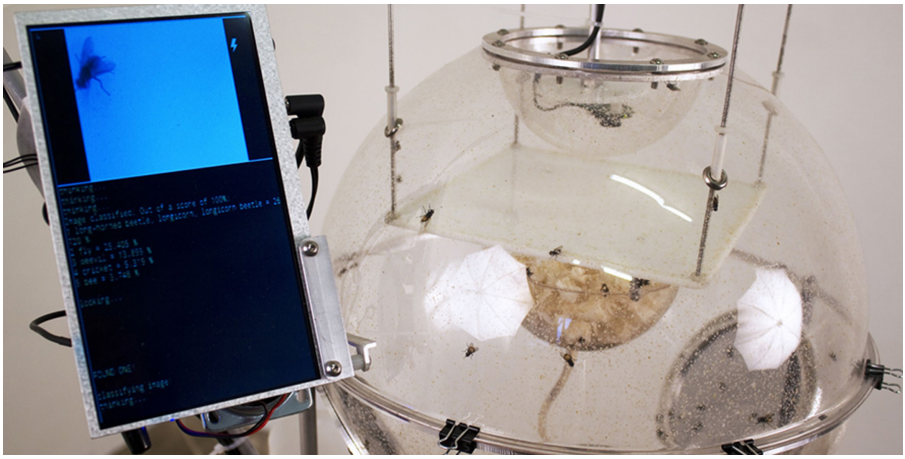

Fig. 1. AI installation "flyAI" created by David Bowen

interactive installation "Variable" inspired by Heidegger's Existence and Time and a description of the artwork on the gallery wall. By inputting the text of "Being and Time" into AI, he made it imitate the writing paradigm in the book to generate algorithmic models, thereby enabling AI to think like Heidegger and write words that no one can understand. The device consists of a wall-mounted metal plate, eight small projectors, and a display box with a five-inch high-definition electronic screen. An eight letters word which means "work name", such as "ACCEPTED" or "MOVEMENT", are projected on the metal plate. These words are randomly generated by the computer, and a long list of corresponding "work description" appears on the screen of the nearby display box. When the visitor presses the button, the work name and work description will be updated accordingly (see Fig. 2).

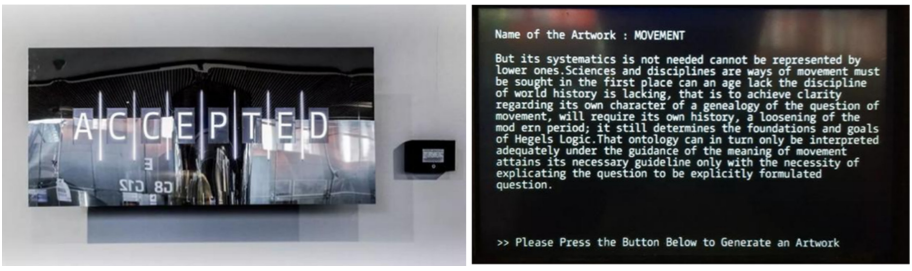

Fig. 2. AI interactive device "Variable"

Interactive-Direct: Third, in this category, AI could serve as an auxiliary creator and interact with audience directly. Although the internal mechanism and generative style are specified by the artist, but the performance of the art object is always changeable and unpredictable, which depends on the actions of participant and can learn from the history of direct interactions automatically. "Dada Landscape" is an interactive art installation

based on AI technology designed by artist Le Zhou based in Shanghai, China, which uses Generative Adversarial Network (GAN) to train AI systems. In this art, viewers draw randomly the simple and abstract lines on the screen, and then the AI processes and renders these lines to recreate a unique Chinese landscape style painting in real time on the interactive interface (see Fig. 3). Another case is that American artist Gene Kogan has developed an interactive device that can migrate neural network image styles in real time. The audience only needs to stand in front of the camera, and the screen can display real-time images of different painting styles drawn by the AI based on the scene and people at the time, which all thanks to the maturity and application of the image style migration algorithm (see Fig. 4).

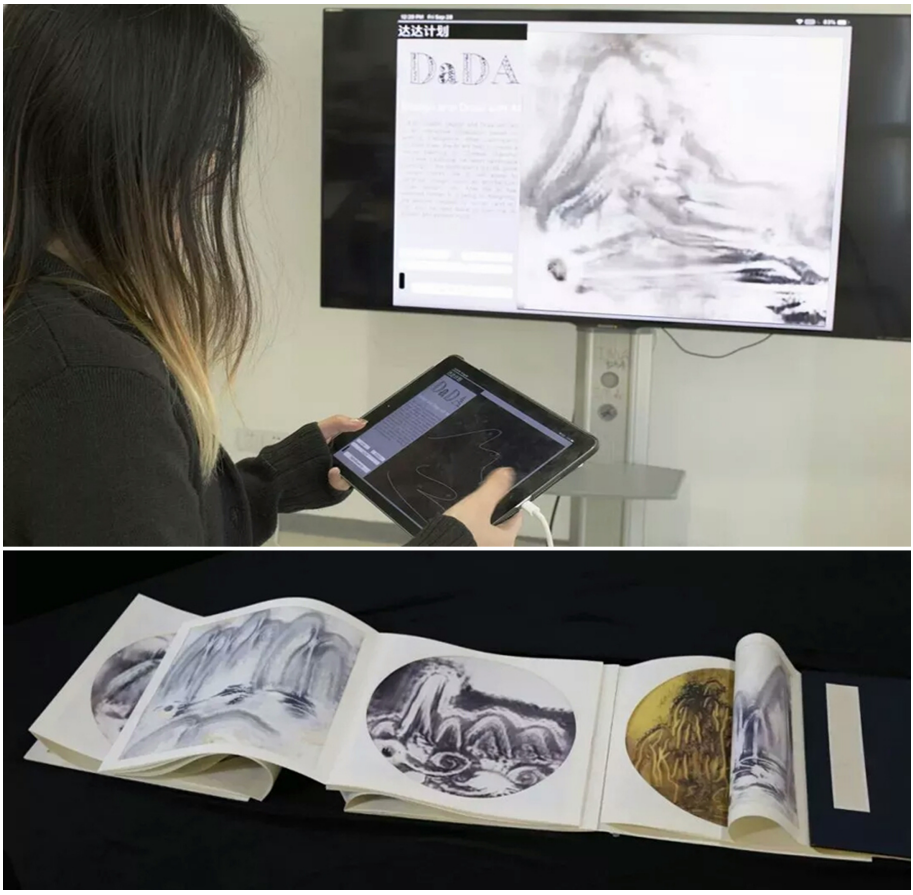

Fig. 3. AI interactive artwork installation named "dada landscape"

In traditional interactive art creations, which are belong to the categories defined as static, dynamic-passive, dynamic-interactive [2], the artists are still in the unshakable position of the creative subject or the doer, who have the power to control everything and set the rules of interaction [3, 4]. Although the audience can interact with the artwork in

Fig. 4. AI interactive art installation

real time, the process and experience of the interaction are predictable. In addition, the original specification of the art object and the performance of the art system can also be unchangeable. Throughout the interaction process, the audience is just a participant, mechanically repeating blunt movements and gestures. Though the presence of the audience forms part of the work, it would lose the value of the most precious thinking of art. In the context of AI, the traditional interactive art creation mechanism has been severely challenged: the core media has changed, the identity of the artist's creative constructor role has been impacted, and the participants have really played a key role. At this time, what kind of interactive art should be established? Can the creative mechanism adapt to the new situation?

The relevant theoretical literature on the mechanism of interactive art creation in the context of AI is scarce, but some scholars have mentioned it slightly. For example, Zaifei Cao [5] pointed out that some artists will still complete their creations alone in the future, but many of them just come up with ideas and achieve the final results with the implementation of AI, which is a more effective cooperation. AI experts Kaifu Li and Yonggang Wang [6] has discussed the relationship between AI and artistic creation from the perspective of AI. They assumed that the artistic creation of algorithms is just based on a large number of studies of human works, which is the simple imitation of a specific creative style of human beings. Liqin Tan [7] mentioned in "Singularity Art" that singularity artists are no longer just creators and information transmitters, but participants and coordinators; experiencers are no longer just external viewers, but also participants and creators. There is no clear distinction between the experiencers and artists. Roy Ascot [8], a pioneer of interactive art creation and theory, founded the world's first cross-media interactive art research center at the University of Wales in 1993, and proposed the five parallel creation methods of "connection, immersion, interaction, transformation, and appearance", and the three characteristics of "connection, interaction, and integration" of interactive art. Cornock and Edmonds put forward the idea that computer could transform the artist from an art specialist in creating artworks to a catalyst for creativity [2]

and the opportunities for including audience participation have been increased by the advent of intelligent digital technology. Collaboration in art practice has grown significantly [9]. American artist Margot Lovejoy explicitly put forward the claim that the complete authorship of the digital age disappeared, and committed to engaging viewers in direct interactive experiences through installations, websites, and books research [10]. Janez Strehove considered the interactive experience is the core content of the creation of digital interactive artworks [11]. HC Hsieh emphasized that digital interactive art mainly focuses on the user participation, operation and action, and pointed out that good interactive system design can promote artistic creation [12]. Lev Manovich mentioned that interactive art, unlike traditional art, is simply tautology and its creation and appreciation can completely become a direct dialogue between the subjects. Any form of expression of the creative subject, whether it is texts, images or sound, can be transmitted to the viewers in real time in the form of digital encoding, and the creative process of the creator can also be shown in front of the viewers. At the same time, the viewers who have any opinions on the expression or creative conception of the artwork can also feed back to the creators in real time by digital coding, and the creators can make timely adjustments to the expression and creation [13]. Peter Webb has deconstructed and reconstructed the future images, that is, had his own unique insight into the relationship between the viewers (the subjects of viewing) and the artistic objects. It is believed that the viewer is not an external viewer outside the artwork, but an internal viewer who will participate in the art world and may also become a new narrator in future multimedia installations. Postmodern art creators have gradually receded from the view of "author is dead" posed by French deconstructionist Roland Barthes. This is not to say the disappearance of the art creators' noumenon, but the audience's participation in the process of art aesthetics, which has constructed and reconstructed the subjects [14].

There are relatively few literary works and dissertations on the interactive art creation mechanism in AI. Although some scholars have analyzed and explored the creative mechanism of AI and interactive art from different perspectives, they are not systematic, comprehensive, and in-depth and broad consensus has not been formed.

The purpose of the paper is to promote the interactive art to build a scientific and efficient creative mechanism that adapts to technological progress and artistic development. The fourth scientific and technological revolution marked by AI has swept the world and has had a profound impact on interactive art creation. In this context, the previous creative mechanism characterized by that artists were the single creative subject, that mechanical or electronic as the creative medium, and that simple interaction between human-machine has begun to falter and is increasingly unable to meet new aesthetic needs. Therefore, this paper has studied the impact of AI on interactive art, the artistic creation of robots, and the creative relationship between artists, robots, and audiences, which contributed to a new mechanism that provides scientific thinking and advanced methods for the creation of interactive art (see Fig. 5).

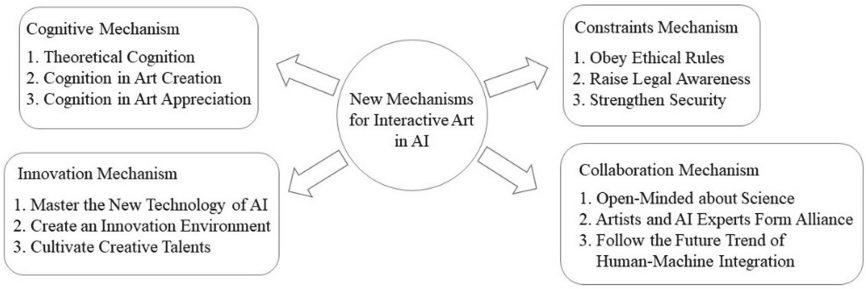

Fig. 5. New mechanisms for interactive art in AI

2 Interactive Art using AI as Core Media

Media is a necessary part of artistic creation which is a process of selecting and using media. The media that artists choose and use is often diverse, but one of them must play a major role and has a core status in the creative process. As a new art form, the interactive art also chooses and uses traditional media, such as text, sound, images, and various materials. However, in the context of AI, artists may use AI as the core medium, making the characteristics of interactive art more distinct, and pushing it to a new stage of development.

2.1 Development of Interactive Art using AI

To a certain extent, the form and value of interactive art are determined by the characteristics of its media which evolves with the development of the times, therefore, interactive art is always changeable and varied. Today's interactive art has obvious digital characteristics, which takes information technology as a carrier and multimedia as its support. From the perspective of the nature of media, AI, as a category of computer science, coincides with the virtualization characteristics of interactive art. Thus, using AI media as a new creative tool is the future development direction of interaction. In addition, from the perspective of media evolution, the media has "humanized trends" [15] and "remedial" [16] characteristics. As a new medium under the development of science and technology, AI cannot escape from humanization and the trends of remedying other media. The original media of interactive art already has multi-sensory interactivity, but it still has a drawback of non-intelligence which can be compensated by the advent of AI technology, so the intelligence of the media will become the future trend. From the perspective of the goal of media development, interactive art takes the emotional interaction with the audience as the ultimate goal. The increasingly humane AI technology has gradually begun to develop towards cognitive intelligence. Eventually, these artificial lives will also gain emotion and aesthetics. Naturally, interactive art will not miss this rare opportunity.

2.2 Role of AI Media in Interactive Art Creation

Canadian media theorist and thinker Marshall McLuhan pointed out the great role of media in the development of human history. He believes that all media are the extensions

of people, which are the enhancement and enlargement of organs, senses, or functions, and have a profound and lasting impact on human and their environment [17]. His media theory clearly tells us that media can transcend time, space, and extend people's vision, hearing, and touch. The change of the media promotes the development of art, which cannot be separated from the media that plays an important role in art creation.

First, AI media can effectively convey the thoughts and emotions of creators. The process by which artists create and display artworks is the process of transmitting thoughts and emotions. Whether a piece of work can effectively convey thoughts and emotions depends not only on the artist's accomplishments, but also on the application of artistic media. The more advanced the art media, the more obvious the communication effect of the artwork. Compared with traditional media, AI media can break away from the constraints of time and space, communicate and interact with audiences in a humane and intelligent way, and integrate virtuality and reality.

Second, AI media can also enhance the appeal of artistic works. The AI media based on computer algorithms and sensors can automatically capture the actions of the audience through the camera, and then send out feedback signals through the output device to interact with the audience, thereby better eliminating the "gap" between the artworks and the audience, enabling the audience to integrate into the artworks, some of which even have good psychotherapeutic effects.

Then, it can provide the conditions for the audience to participate in the creation. In the information age, everyone can become an artist, just like Negroponte said that the digital highway will make the saying "completed and unchangeable works of art" become a thing of the past. Nowadays, people don't even have to move, but can create works of art with their fingers, which is the charm of interactive art. But in the past, the interaction between audiences and artworks was a programmatic, boring process, and interactive feedback was relatively simple. AI media is quite different from other media, which is not only an extension of human senses and limbs, but also an extension of human intelligence. This extension provides favorable conditions for audiences to participate in creation.

Finally, AI media can liberate artists' labor and stimulate creativity. In the future, AI can free humans from repetitive, regular, and simple tasks that take a lot of time, leading to a significant increase in productivity. But Massimo Negrotti believes that "The analysis-simulation" inherently mentality makes AI unable to handle things like creativity which is a kind of abilities with ambiguity, complexity and integrity [18]. Although artistic creation is considered to be a vivid expression of human creativity and emotional thinking, there are also non-creative labor parts in artistic practice, such as the process from unfamiliar contact to skillful use of tools, the mental labor process of cultivating creative skills and hands-on ability, which require the artist to invest a lot of time and energy to learn, hindering the exertion of creativity. If the labor part of artistic creation can be replaced by AI, then human creativity, free will and emotions can be released and expressed to the greatest extent, and art can become real art.

3 Creative Multi-Subjects of Interactive Art

The creative subject is one of the necessary constituent elements of artistic creation, which is the initiator of the artistic activity, and a practitioner with certain creative ability

and aesthetic ability. Without the existence of creative subjects of artistic creation, art will not be born. The famous aesthetician and art historian E. Gombrich frankly acclaimed, "There really is no such thing as Art. There are only artists" [19]. This is enough to show the importance of the creative subject of artistic activity to art.

3.1 Artists in Interactive Art Creation

On the one hand, in order to achieve the ideal interactive results in the mind, the past interactive artists had to personally write computer programs. From the perspective of media development, the more the media becomes humane, the more autonomy and control people enjoy while using the media. With the maturity and development of AI technology, interactive artists may no longer be trapped in the captivity of professional knowledge. Therefore, the artist's emotion, recognition, and creativity has been strengthened and improved.

On the other hand, the artist is the initiator of the artistic creation activity, whose mind is the core of the artistic work. Art exists because the artist desires to express himself, evoke resonance, and recall the past. Although AI can replace part of the artist's labor, the part that will become art cannot be replaced by AI, which are the artist's desire to break through limited time and space, the desire to express himself, and the desire to communicate. AI does not have these social attributes and consciousness, thus naturally there is no original intention to create art. In the process of AI participating in the creation of interactive art, although the artist's participation is reduced and his authorship is weakened, he still has an absolute advantage in thinking orientation.

3.2 Robots in Interactive Art Creation

Today, robots have become a part of our daily lives, which have become "brush" tools and powerful assistants in the hands of artists, changing the traditional way of artistic creation in the past. With the in-depth application of AI technology in the field of robotics, intelligent robots will shake the position of the artist's creative subject, let the artist retreat behind the scenes, and then independently complete a series of artworks. In the interactive art, the subjectivity of intelligent robots will also become more and more obvious, which can even achieve emotional and ideological communication with the audience in the near future.

Before the advent of AI, it was not unusual for artists to use robots to create artworks. "Robotic art not only combines the skills of programmers and painters, but also combines the sensitivity of sculptors, installation artists, and performers with the orderliness of computer systems equipped with sensors and mechanical effectors" [20]. Therefore, robotic art is actually a kind of mechanized art, but there is a disorderly, subconscious beauty in this established stylized creation [21].

According to the degree of participation of robots and artists, we divide robotic art into four different types.

1. The artists retreat behind the scenes, and robots have become creative subjects. The creative subjects here are not really creative one, because these robots do not yet

have the learning ability and intelligence, but only follow the instructions given by the artists, and most of these artworks are robotic paintings and sculptures.
2. The other is that robots and artists work together to participate in art creation. Robots often work with humans and learn from our behavior. Contemporary artists seem to realize the connotation and important value of human-machine collaboration, and quickly apply the results of science and technology to artistic creation. Machines have expanded the human body. Therefore, when artistic creation methods exceed the physiological limits of humans, it is time for machines to show their skills.
3. In addition, robots have become a medium for artists to express their own ideas, and a vehicle for metaphorizing the relationship between machines and humans, people and people, society and nature. "Human-machine art is a way of expression that compares to the essence of human by taking advantage of machines to pay attention to the social history, realistic living environment, and state."[22].
4. Finally, robots are other things created by humans in accordance with the ideal image in their hearts, and are an extension of human limbs and intelligence. Many artists have begun trying to use machines as part of their limbs in order to push the limits of the body.

With the gradual deepening of AI technology in the field of robots, robots are undergoing a process of transforming from the so-called tools and media to assist artists in artistic creation to becoming truly creative and intelligent art creating subjects. Because of the growing maturity of computer vision technology, robots were first given human visual abilities, so the first breakthrough in intelligent robotic art was in the field of painting, especially portrait paintings (see Fig. 6). With the development of AI technology, the role and status of robots in artistic creation will become more and more obvious. Although it looks like human confront machine to determine the mastership of future art, in fact, it is difficult for limited human biological intelligence to combat the development of non-biological intelligence. The better way is to combine human and artificial neural networks to make them work together to develop their creativity [23].

Fig. 6. P. Tresset, 6 Robots Named Paul (cited from internet).

3.3 Audience in Interactive Art Creation

The audience is the receiver and responder of art information, the object of art transmission activities, and the promoter of art development. Without the appreciation and evaluation of the audience, artistic creation can only be regarded as an artist's pastime and monologue, so the role of the audience is also crucial to artistic creation. Looking through the development of art, it is actually a process of improving the status of the audience, which is changing from the viewer to the participant and then to the creator.

In the process of appreciating traditional art, the audience can only stand in front of the artwork from a long distance, so it is difficult for them to speculate on the artist's true thoughts and intentions, and to reach an emotional "resonance" with the artist. Moreover, the creative power is also in the hands of the artist, but viewers have only the right to appreciate and comment. The advent of interactive art broke this unequal dialogue relationship, whose biggest feature is interactivity. As a result, the artist gave up some rights and provided only context and parts of content, and the audience is no longer just the single role as a viewer. They can participate in the process of artistic creation, become a part of the work, and even a creator. But this is just a dance in a cage. The artist is like the game maker, and the audience can only participate in the game according to the rules. In the context of AI, the medium of interactive art has become more humane and the interaction process is more intelligent. In the future, the audience can finally break away from the shackles of the rules and freely use their imagination to give the work a whole new meaning. British artist Roy Ascot profoundly predicted: "The role of the artist / author has changed from a person who fully controls over the whole creation of an artwork to a person who designs a 'frame' or 'ethnological' structure that invites extensive collaboration among the general public." "The art observer is the audience, who no longer just watches from the outside like a bystander, but also participates in and become the central figure in the creative process. Art not only opens a window for the audience to understand the world, but also builds a door for the audience, inviting them to enter this world of interaction and transformation." [8]. Therefore, in the context of AI, the role of the audience in interactive art has undergone a fundamental change, which is no longer a bystander in the original sense, but a participant and a creator.

In the AI interactive art, the process of interaction has become more diversified and humanized, and the results of interaction have become richer and different from person to person. Different audiences' aesthetic cognitions, personality characteristics, and personal styles provide a wealth of materials for AI to view the world and understand the world, giving interactive artworks new souls and lives. For example, on the online art generation webpage named Deep Dream Generator based on Convolutional Neural Network (CNN) technology developed by Google, users can choose original materials, migration styles and related parameters according to their preferences, and leave all the rest to AI to complete. In just ten seconds, the user can get a piece of artwork with his own strong "machine" style (see Fig. 7).

4 New Mechanisms for Interactive Art Creation

Mechanism originally refers to the structure and principle of machines in engineering, which is borrowed from the category of social sciences to explain the composition of each

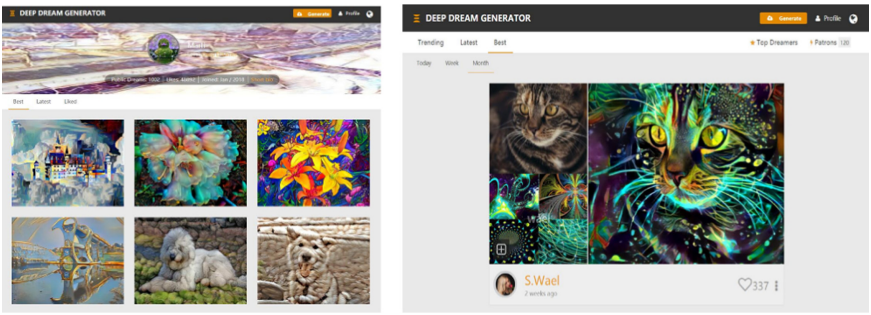

Fig. 7. The artworks of some users on "Deep Dream" homepage

element in the system and the way of operation between them. The so-called interactive art creation mechanism refers to the organic connection and operation between the various elements of the interactive art creation system, which is the method, approach and process that artists and the audience as the main actors of art use media, such as computer technology and tools to create and communicate. Art creation can be divided into narrow sense and broad sense. Narrow sense of artistic creation refers to the creation of individual artists; broadly defined artistic creation refers to the process by which social organizations, artist groups and the public perceive art, participate in art, create art, and disseminate art. The artistic creation mentioned in this article is the artistic creation in a broad sense. Individual artists have differences in knowledge structure, cultural background, cognitive ability, ideology, and technical means, and it is difficult to grasp the individual creative mechanism. Only by understanding and understanding artistic creation in a broad sense can we better study the creative mechanism of interactive art and better grasp the creative rules of interactive art.

4.1 Cognitive Mechanism of Human-Computer Symbiosis

Cognition refers to the psychological behaviors and processes that people obtain information and understand the world around them through observing, feeling, experiencing, and thinking. Cognition is also a process of continuously acquiring knowledge, applying knowledge, and then obtaining new knowledge, which is the basis of artistic creation. Only by establishing a scientific cognitive mechanism can interactive art creation be carried out in depth.

The theoretical cognition of interactive art is the premise and foundation of interactive art creation. Without a certain knowledge of interactive art theory, interactive art creation cannot be carried out. With the application of AI in the field of art, many artists would feel anxious and confused, because their creation lacks theoretical support, motivation and direction. To change this situation, strengthening interactive art education and research may become an important measure. Governments, universities, research institutions and related enterprises should work together to focus on AI technology and establish interactive art education and research systems. Specifically, we could start from the following aspects: First, we can establish a penetrative cross-discipline of AI and interactive art, set up a relevant specialty and provide professional courses in interactive

art, and cultivate composite talents who understand both AI and interactive art. Second, we can vigorously study and learn from the latest achievements in the research and practice of interactive art, and grasp the creative ideas and development trends of AI art. The third is to strengthen the theoretical research on interactive art and explore the relationship between AI and interactive art. Finally, germinated AI art can be summarized and condensed in time to find the regularity and form a systematic theoretical system.

Artistic creation is the way and means used by art creators to express ideas, reflect society, and communicate with others. It reflects and embodies the creator's cognitive process in aesthetic judgment, creative thinking, creative techniques, and the use of media materials. The emergence of any new technology will bring new tools and media to artists, and will also change their thinking mode and knowledge architecture system. On the one hand, the birth of new media means that artists could attempt to try creative approaches and innovative methods that they have never used before in artistic creation. This tentative practice may give artists a new perspective and new concept in aesthetic activities; on the other hand, the application of new media extends and expands the artist's senses and body, allowing the creators to break through their own limitation of time and space, and the past recognition of experience, which have created conditions for them to explore a wider physical and spiritual world. Similarly, the application of AI media in interactive art creation has also changed the artist's perception of the artistic activity itself. Different from the previous creative media, AI has the ability of autonomous learning and thinking to create artworks that belong to the unique aesthetic cognition of AI, which are weird and bizarre, varying from the normal aesthetic experience of human beings. But the artist seems to have found a key to the door to the new world. Although it is impossible to understand the process of AI to create art, these unique styles of art can give the artist new inspiration and recognition. "The best design is to combine intent and bizarre elements, and finally create unexpected new things." [8]. Conversely, the creators can also impart their own aesthetic experience to AI and let it understand and learn.

Art appreciation is an aesthetic cognitive activity that art participants or audience view, think and criticize on the artistic creation process, artistic images and artworks, including art appreciation and art criticism. For a long time, the evolution and change of the media not only expanded people's aesthetic cognition in time and space, but also affected and even determined the standards of appreciation and judgment on artworks. In this context, the human aesthetic field will be greatly expanded and the standard of aesthetics will also change dramatically. "Aesthetic standards, appreciation, and criticism may be a form of aesthetics dominated by non-biological intelligence in the future, which determines the development and reconstruction of future art. To this end, artists must practically master or creatively possess technical intelligence. This is a wise choice" [7]. A work of art created by AI has its own beauty and composition, and may be very divergent from human aesthetics and aesthetic methods, but the machine does not destroy the aesthetic ability of human nature, but only transforms the inherent mode of thinking of human intelligence and offers another possibility beyond aesthetic standards.

In general, establishing the "human-computer symbiosis" cognitive mechanism is to build the "human-computer symbiosis" cognitive concept, which need us to strengthen the theoretical knowledge of AI and interactive art, and make a good knowledge reserve

before the creation; to strengthen the understanding of the nature, characteristics and laws of AI interactive art in the creation, and find the best combination of AI and art; to strengthen the aesthetic cognition after the creation, so that the audience and participants can get spiritual satisfaction and emotional pleasure in appreciation, and distinguish beauty and ugliness, good and evil in criticism.

4.2 Innovation Mechanism supported by Intelligent Technology

In AI interactive art creation, it is not enough for artists to cooperate only with scientists and AI experts. They also need to focus on tracking and absorbing the latest developments in AI in time, so that they can better apply new AI technologies to their creations, which puts forward higher requirements for artists. "AI interactive art is a very challenging art. Those who are engaged in this process must understand all kinds of cutting-edge technologies, master experimental and operating methods, learn about production processes and procedures, and be familiar with art innovation forms and art philosophy." "The technical factors in the art creation of AI are based on advanced technologies, such as modern sensing technology, network technology, 3D printing technology, simulation technology, virtual and augmented reality, biological gene technology, and high-tech materials, and then to realize the intelligentization of art design, manufacturing, and presentation through intellectual perceiving, human-machine collaboration and fusion, and other methods. It is actually a deep blend of AI and human intelligence" [7]. Therefore, understanding and mastering the latest developments in AI is a necessary prerequisite for interactive art creation.

Interactive art is not only a display art, but also a practical art. We should not only build intelligent exhibition halls, museums and art galleries to display new works of interactive art, but also improve the artworkers' innovative consciousness through marketization and commercialization, forming a competitive mechanism for interactive art creation to achieve survival of the fittest. We could also vigorously expand and make full use of public space, integrating interactive art with public art to increase the enthusiasm, initiative, and creativity of audience in participating in artistic creation. At the same time, the state could introduce related policies, establish an innovation service platform, encourage the innovation and application of interactive art, and reward those who have made outstanding contributions in the creation and dissemination of interactive art.

Throughout history, those who have made great contributions to the development of art and technology are all those with innovative spirit, innovative awareness and innovative knowledge. In order to promote the development of interactive art, it is important that cultivating the talents in innovation of interactive art should be given priority. As the product of the integration of technology and art, AI interactive art is a very typical interdisciplinary subject. Therefore, in order to cultivate artistic creative talents that can meet the needs of the development of the times, colleges and universities need to adopt a multidisciplinary and integrated innovative education mechanism, build interdisciplinary scientific research platform, set up interdisciplinary academic research teams, construct new discipline systems, improve interdisciplinary teachers training mechanisms, and other measures to promote interdisciplinary cultural exchanges, achieving comprehensive development of talents.

For example, the Massachusetts Institute of Technology has specifically established the Center for Arts, Science, and Technology (CAST), which works with various departments, laboratories, and research centers within the institute, through developing new professional courses, cooperating with visiting artists, providing research funding, sharing activities, and other innovation models that integrate teaching, scientific research, and communication to link art, science, and technology. In addition to universities, companies have also played an important role in leading the development of art and technology, and the cultivation of innovative talents. In the era of big data, many Internet companies which rely on their unique advantages can occupy first-hand data information, grasp the latest cutting-edge technology, and attract a steady stream of high-quality resources, which have played a driving role in fostering and promoting the cultivation of innovative talents. Some Internet giants have begun to realize the importance of composite creative talents, so they have taken the lead in building open source technology platforms, setting up cross-field laboratories, creating scientific project teams composed of researchers with different professional backgrounds, and establishing incubation bases, which provide new opportunities and platforms for the integration of art and technology, the exchange and collision of different thinking.

4.3 Collaboration Mechanism in Creative Subjects

Collaboration is coordination and synchronization. To produce good interactive artworks, the creative subjects must maintain coordination and synchronization to form a cooperative mechanism of benign interaction.

Art and science belong to the two levels of human cognition. Although they differ in form and content, the goals they pursue are the same, which both reveal the nature and laws of objective things and have promoted the progress of human society. On the one hand, science opens up new research fields and provides new creative means for art; on the other hand, art creates imaginative space for science and inspires thinking. From the perspective of art, every great prosperity of art and the birth of new art forms are the result of the advancement of science and technology. Therefore, as an artist, we should not turn a blind eye to the development of science and technology, but timely track and vigorously apply the latest achievements of scientific and technological development. In short, "In modern society, an artist must fully define himself and seek the help of science, using it as a tool and reference." "Except for accidents, artists should seek advice from various sciences." [8].

In the context of AI, it is impossible for artists to work alone and fight alone to create meaningful and impressive artworks, because AI is the result of the intersection, penetration, integration and development of interdisciplinary disciplines, and also the mutual infiltration of natural sciences and social sciences, which are highly comprehensive, involving computational science, information science, mathematics, neuroscience, philosophy, etc. Interactive art is a cross-border and comprehensive art, which is high in science and technology, so artists will be bound to be limited by knowledge and technology in the creative process. Therefore, in the practice of interactive art, artists should form alliances with AI experts to turn "art studios" into "science laboratories", learn from each other and co-create. The most well-known and informative case is the new media art team named "Team Lab" from Japan. They have created many highly

technological and immersive digital interactive artworks that make audience feel unforgettable and impressive. To a certain extent, their great success is inseparable from its cross-scholastic "ultra technologists" team. These team members are composed of professionals in various fields such as artists, programmers, engineers, CG animators, mathematicians, and architects. "The advantage of teamwork lies in their unified coordination of knowledge structure and background. When creating an artwork, everyone will be responsible for the professional field they are good at, thus the technical level, visual effects and maturity of the artwork are guaranteed to a considerable degree." [24].

With the rapid development of AI technology, machines will become more and more intelligent, and human-machine integration is imperative. The so-called integration is that human and machines are interwoven with each other. On the one hand, AI media, as an extension of human senses, limbs and thinking, has expanded human physical fitness and intelligence, and can help people perform large-scale calculations, inferences and judgments, completing tasks impossible for the human brain; on the other hand, human have also helped AI gain perception and cognition. Human-machine integration is a slow and gradual process, which is mainly divided into the three levels of development: perception fusion, behavior fusion, and thinking fusion. In interactive art creation, machines and artists have realized perception fusion and behavior fusion: computer technology and sensor technology can simulate the artist's perceived behavior, allowing machines to obtain vision, hearing, touch, and taste, etc.; the development and application of robots have extended the artist's senses and limbs, allowing robots to have behavior and perception capabilities similar to human, which can become a tool for assisting the artist's creation or even the subject of creation; the relationship between human and machine will be further advanced in the context of AI. After perceptual fusion and behavioral fusion, the machine will also acquire human cognitive intelligence, which is the simulation of thinking and consciousness, at this time the development of "human-machine integration" will reach the highest stage-thinking fusion. Now, interactive artists have begun to try to create artworks with AI. In the future, works of art that interact with the audience are not necessarily created by the artist alone, but may also be the wisdom of AI. As shown on the page of Deep Dream, an online art creation software based on AI technology launched by Google, the future of art must be the future of human-computer collaboration and mutual integration (see Fig. 8).

4.4 Constraints for Creative Behavior

The application of AI into artistic creation will bring moral hazard and raise ethical issues, such as whether AI can replace the position of artists? Does the artist plagiarize the creation of artificial intelligence as plagiarism? Can AI create artistic works as it wants, without moral constraints? Can AI artworks enter the art market and enjoy the right to be auctioned? In the stage of mechanical automation, AI has not yet generated a certain degree of self-awareness and thinking, so artists only use AI technology as a creative tool and medium. The subject of artistic creation is still a person with free will and soul. However, once the development of science and technology has entered the era of strong AI, or even super AI, that is, the stage where AI has surpassed human intelligence, artists have to face the dilemma of being challenged by the subject. The arrival of this stage is only a matter of time. It does not help whether oppose or reject

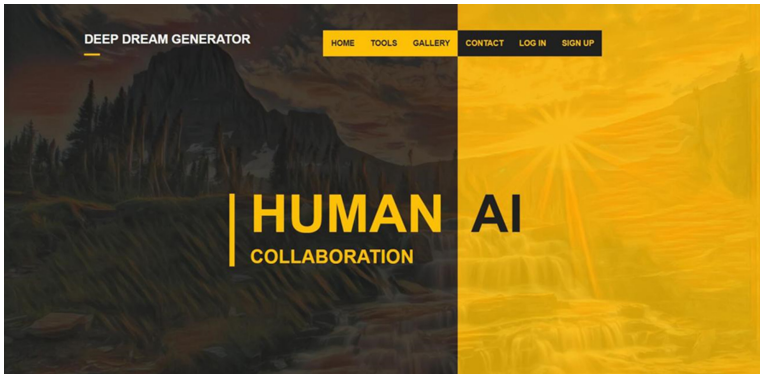

Fig. 8. Interface of "Deep Dream"

the creative talent of AI from an emotional or moral perspective. We have to consider formulating relevant ethics in advance to restrict AI and the behavior of artists. On the personal level, we should improve the artist's sense of moral responsibility, and enhance civil cultural literacy and ethical concepts; on the technical level, we should integrate AI with philosophical ideas, strengthen technical communication and cooperation, etc., so that we could create a good future for the positive, healthy and upward development of art environment and prospects.

In addition to ethical issues, the application of AI in artistic creation also brings legal risks and authorship issues. The issue of attribution and identification of copyright in AI creations are highlighted. If we are vague about the concept of the protection of the copyright of AI creations, it will lead to an imbalance of interests between potential rights subjects, which will hinder innovation and development in the art field. Therefore, experts in the legal field need to think and formulate relevant regulations to ensure the interests of relevant people and raise everyone's legal awareness.

AI technology, like other technologies, is a double-edged sword. If it is used reasonably and normatively, it will benefit human beings; on the contrary, if it is used by criminals, it will bring disaster. With the development of interactive art towards intelligence, interactive artworks have formed a "fate community" with human beings. A great number of interactive artworks are not only displayed in public spaces, but also widely used in social production and life. In this case, security awareness and precautions are particularly crucial. We should prevent a small number of artists from using interactive art against society and humanity; we should prevent the phenomenon of violent tendencies, uncontrolled procedures, and racial discrimination that may occur with artistic robots. Especially when AI develops to a certain degree, interactive art works may be closely integrated with human brain, body, and even psychology. We should be more careful about the harmful effects of certain bad artworks on human physical and mental health. Therefore, it is necessary to establish safety standards for interactive artworks and strengthen the assessment and monitoring of the safety of interactive artworks.

5 Conclusion

This article starts from the basic concepts, development status and trends of AI, collects and analyzes a large number of domestic and foreign literature and related cases, and discusses the background of AI's intervention in the field of art and integration with interactive art. In this context, the core media and creative subjects of interactive art are facing huge changes. The past interactive art creation mechanism has been unable to adapt to the development of the new situation. On this basis, this article analyzes the inevitable trend of interactive art's use of artificial intelligence as its core medium and its important role in two chapters, and discusses the diversified characteristics of the subject of interactive art creation. Finally, based on the above analysis and demonstration, we construct a new mechanism for interactive art creation to guide the practice of interactive art creation in the context of AI.

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