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Development, Inheritance and Innovation of Digital Art Based on Human-computer Interaction Intelligent Network Virtual Technology

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Abstract: With the development of the times, traditional art forms have also faced new challenges. With the outbreak of the scientific and technological revolution, network information technology began to enter various fields, including the art field. Through the integration of traditional art and electronic information technology, a new digital art form has been developed. According to the current development situation of digital art, this paper designed a human-computer interaction system for digital art. The system mainly included music art module, dance art module and image art module. The traditional art form can be digitized by computer system, which can make it become system data, and then the data can be transformed into corresponding digital art form by computer system algorithm. The tests in this paper ensured that the system can operate completely and normally, and made a random comparative analysis of its performance with traditional art forms. According to the results of data comparison, the human-computer interaction system of digital art was far superior to traditional art forms in all aspects. The recognition of digital art through this system also reached 80% of the respondents, and 70% of the respondents said that they were very satisfied with the use experience of digital art human-computer interaction system. Through the investigation of the masses, it was finally determined that the digital art human-computer interaction system had considerable guidance for traditional art, and effectively inherited and developed the traditional art culture.

1. Introduction

At present, the traditional art form is undergoing transformation. With the rise of the Internet, all kinds of fields have entered the operation mode of Internet plus, including the art field. Art, as the crystallization of human wisdom, integrates various human thoughts and feelings. Now, with the rise of the computer industry, people have found a new art form in the virtual electronic data, that is, digital art.

Although the concept of digital art has emerged for only a few decades, many scholars have studied it from many aspects and angles during this period. Franceschet, Massimo believed that art should abandon the traditional concept of entity and accept the new concept of digital art, and put forward a decentralized view on digital art [1]. Cetinic, Eva had unique views on art and artificial intelligence. He believed that art can get a new development through artificial intelligence, which can replace human beings to complete some art forms that are currently difficult for human beings to complete or achieve [2]. Dalia, Yoseph felt that art was everywhere. He believed that there was also art in medicine, and talked about the relationship between art, network and medicine [3]. Cosier, Kim was very worried about the current situation in the art field. He believed that the infiltration of network technology into art would lead to the art going astray, and carried out in-depth discussion and analysis on this, and described the various hazards of network art [4]. It can be seen from the above documents that although the discussion on the field of digital art is very extensive at present, these documents have not comprehensively explained the practical application of digital art. Their opinions are somewhat subjective and their theoretical methods are not scientific.

In view of how to systematically apply digital art, this paper has launched an in-depth exploration of digital art. Fish, Barbara J believed that art had therapeutic effects. In his article, he described the therapeutic effect of art and talked about whether digital art also had the possibility of treating patients. He combined history with modernity and systematically described the therapeutic value of art [5]. Vereshchahina-Biliavska, Olena Ye believed that music art can also combine with modern network technology. He developed classical music art into modern digital art, and gave his own view [6]. Grant, Catherine put forward his own view in the article on decolonization in the history of art. He believed that art changes according to the development of the times, and art had strong characteristics of the times. Modern society has begun to enter the information age, so the emergence of digital art was in line with the development process of art [7]. Muzafarovna, Avliyakulova Nafisa expressed his views on art. He believed that folk decorative art would be affected by religious beliefs. Therefore, he believed that decorative art was not suitable for combining with modern emerging digital art, which belittled and denigrated traditional religious beliefs [8]. According to the review and understanding of the above documents, it was found that although these documents had unique views on digital art, most of them had also made systematic evaluation in combination with relevant actual objects. However, through careful reading, it was found that such articles had not been completely compared and evaluated in art. They were all about the advantages and disadvantages of their own digital art in a single form.

Based on the literature review, this paper summarized the shortcomings of this kind of literature, and decided to carry out a systematic analysis and discussion on digital art. Through the analysis of the development, inheritance and innovation of digital art based on human-computer interaction intelligent network virtual technology, this paper comprehensively explained digital art and analyzed the differences between digital art and traditional art.

2. Design of Human-computer Interaction Intelligent Network Virtual Technology Method

Art is an abstract conceptual thing, and its forms and methods of expression are also diverse. The most common forms of art are as follows: dance art, image art, music art and human performance art [9]. In order to meet the digitization of these kinds of arts, this paper plans to design a network virtual system platform that includes character capture, virtual character creation, audio recognition and image recognition. It is also called digital art human-computer interaction system. Through this system platform, the actual characters' models, images, sounds, actions and other artistic behaviors are converted into data, which can be uploaded to the terminal platform, thus achieving the purpose

of art digitization. At the same time, the system platform also includes the composite classification function, which sorts all the art fields for users to quickly screen and find the appropriate art classification they like. The following is the flow chart of human-computer interaction intelligent network virtual technology, as shown in Figure 1:

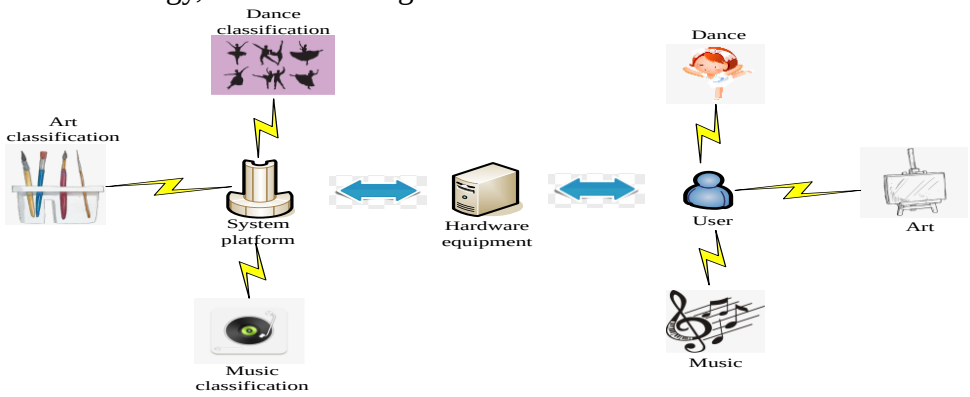

Figure 1: Flow chart of human-computer interaction intelligent network virtual technology

2.1 Dance Character Model and Motion Capture Method

If people want to digitize the dance art, they first need to capture and analyze the movements of dancers, and record the movement data of dancers through physical devices. Secondly, according to the actual body data of the dancer, a virtual 3D character model is established through the network, and the dance movement data is imported into the virtual 3D model. The virtual 3D model would make corresponding dance actions according to the imported data parameters, so as to achieve the goal of digitizing dance art.

Firstly, the dancers were required to wear 39 human bone and joint position marker patches, and then affix marker patches to 10 fingers and 14 other auxiliary positions, a total of 63 marker patches. The initial space position of 63 marker patches can be recorded, and the space position of marker patches can be changed by the user's limb movement. The position data of the marker patch after movement can be recorded and uploaded to the virtual network system for processing, thus obtaining the relevant movement direction data of the part. After obtaining these data, they can not be used immediately. These data also need to complete the movement through a carrier, that is to say, a virtual 3D character model needs to be built. The 3D character model mainly includes two parts, the external model design (also known as skin) and the internal human skeleton construction. In order to simplify the process of skin and bone construction, this paper adopts the shape technology of neural fusion. This technology can accurately bind the skeleton of the character with the external model, so that the external model would not lead to threading or other problems due to the change of the internal skeleton frame. The shape technology of neural fusion mainly includes envelope deformation branch and residual deformation branch. The envelope deformation branch learns the parameters of a specific skeleton level composed of offsets through indirect supervision, and finally predicts the skeleton, skin and weight binding from the input character model. The global transformation of each vertex is calculated based on the skin matrix, and its calculation formula is as follows:

$$G_{B_k} = \sum_h X_{kh} U_h \tag{1}$$

Once the transform is calculated, the per-vertex mapping transform $G_B = G_{B_k}$ is applied to the input character:

$$\tilde{S}_B = G_B \Delta S \tag{2}$$

Δ represents the per-vertex operation of global mapping transformation G_B on the input vertex, and U_h represents the conversion of local joint rotation and offset to global mapping of each joint transformation. S represents the offset of the predicted bone of the enveloping deformation mesh, that is, the offset of each joint from its parent joint. However, the figure model predicted by this method would have some subtle problems in actual use, which may cause the skin of the model to sag, so it also needs to be technically processed through residual deformation branches. The residual deformation branch can predict the corresponding fusion shape according to the input model mesh connection. It generates a group of A residual shapes $\{C_h\}_{h=1}^{A}$ through mesh convolution blocks in the residual mixed shapes, and inputs a small neural network module at the same time. Each block is conditionally set by the rotation of a single joint, and the resulting coefficient $\{\beta_{hk}\}_{h=1}^{A}$ is used to interpolate the residual shape accumulated and added to the input vertex. Its calculation formula is as follows:

$$\tilde{S} = S + \sum_{k=1}^{K} \sum_{h=1}^{A} \beta_{hk} N_k C_h \tag{3}$$

N_k is a binary mask that specifies the vertices associated with the joint.

A virtual 3D character model is finally obtained through the neural fusion shape technology of enveloping deformation branches and residual deformation branches. The advantage of using this method is that the texture of the model is more realistic and natural, the skeletal muscle is more realistic, and the human intervention on the model is greatly reduced, and the quality of the model is greatly improved.

2.2 Digital Method of Music Art Sound

As the most popular form of artistic expression, music art is deeply loved by the people [10]. With the development of the times, the inheritance of music art is also changing, from the early paper music to the digital electronic audio [11]. Music sounds are produced by the vibration of the sound object, and have a fixed frequency. Each piece of music has its own unique melody speed. If people want to extract a musical note, they first need to process the music by frame. Generally, the fastest clapper is 184 beats per minute, while the slowest clapper is 46 beats per minute. The meaning of each note includes not only the pitch information, but also the time of the sound produced by the note. For example, the 2-minute note represents 2 beats, and the 4-minute note represents 1 beat. Most songs can use up to 32 minute notes, and the duration formula is:

$$U = \frac{4}{s} \times \frac{60}{d} \tag{4}$$

In the formula, s is the note category, and d is the music speed and beat number. According to the above formula, when the music is played at the fastest speed, the time required for a 32 minute note is about 40 ms. Therefore, when dividing music frames, try to avoid the situation that one frame is less than 40ms. After the frame processing, the next step is the key to the conversion of music art digitization, which is to sort and combine the music from the frame. The computer program system calculates it to get the spectrum, and the system would send out specific sound according to each spectrum, so as to achieve the purpose of digitizing music art [12]. The system

uses Fourier algorithm to extract music frames. The Fourier algorithm formula is as follows:

$$X_n(e^{j\delta}) = \sum_{m=-\infty}^{\infty} y(m)\delta(n-m)e^{-j\delta m} \tag{5}$$

In the formula, $y(m)$ is the music signal sequence and $\delta(n-m)$ is the real number window sequence. When n is different, the window function would select different music frames for Fourier transform according to different time to obtain the music spectrum. After the spectrum is obtained, it is also necessary to process the spectrum, that is, use the sub-harmonic summation to process the spectrum. This method mainly uses the relationship between the octave and the fundamental frequency of the music, and weights, compresses and sums the spectrum to obtain the estimated spectrum of the fundamental frequency. The sub-harmonic summation formula is as follows:

$$Y_v = \frac{1}{4}X_{v-1} + \frac{1}{2}X_v + \frac{1}{4}X_{v+1} \tag{6}$$

X_v represents the frame points of each note in the spectrum, and Y_v represents the frequency points of the spectrum after weighted average. Through the above formula, the music art sound can be completely converted into digital music art music spectrum that can be recognized by the machine through computer hardware equipment.

2.3 Digital Methods of Image Art

As the most common carrier of art forms, image art has a very long history. The main form of expression of image art is what people often call pictures, that is, paintings. Before entering the era of digital electronic information, image art mainly took physical painting as its main form of expression, which has existed for thousands of years, and has an indelible contribution and role in the inheritance and development of image art [13]. However, the traditional physical image art also has corresponding shortcomings, that is, the time cost of physical painting is too long, and the level of painting personnel would also affect the quality of painting. This kind of problem can be effectively solved by digitizing the image art. Through image recognition technology, the physical image information would be recognized and scanned into a computer, which would process the image and quickly generate images of art forms such as oil painting according to different needs of users. Before generating other art forms, the system would first process an image color gray value for the input image. Its main purpose is to reduce the volume of image data and improve the digital recognition ability of the system. The image color calculation formula is as follows:

$$Z = aA + bB + cC \tag{7}$$

In the formula, Z represents the color value of the composite color, A, B, C represent the component value of the red, green and blue colors in the pigment, and a, b, c represent the proportion of the three colors in the color pixels. According to the colors contained in the image, the average method is used for image graying. The average method image processing formula is as follows:

$$A = B = C = (A + B + C)/3 \tag{8}$$

The average method is one of the most common and commonly used methods of image grayscale processing. Using the average method to process the image grayscale can make the

processed image softer and better highlight the artistic characteristics of the finished image. After graying the image, the system would carry out a series of technical processing on the image, and finally complete the digitization of image art, forming various forms of digital image art works.

3. Human-computer Interaction Experiment Test of Digital Art System

Through the design of the above three sections, a complete human-computer interaction system for digital art was finally built. However, the completion of the design does not mean that the system can operate normally. It is also necessary to test this function to confirm whether the system has abnormal conditions. In order to verify whether the system can operate normally, this paper randomly selected some experimental materials to detect it, and judged whether it has abnormalities through the detection data.

3.1 Dance Art Module Test

After obtaining the consent of the dance teacher, this paper puts on relevant detection equipment for them. In order to randomly perform several dance movements for the experiment, the computer performed corresponding operations according to the motion data of the dance teacher, and produced the standard data of 3D virtual dance. The standard rate data table of 3D virtual dance movements is shown in the following Table 1:

Table 1: Standard rate data of 3D virtual dance movements

	Dance 1	Dance 2	Dance 3	Dance 4	Dance 5
Beginning part	98%	99%	97%	98%	100%
Climax part	99%	99%	96%	97%	99%
Ending part	97%	99%	95%	96%	98%
Mean	98%	99%	96%	97%	99%

According to the test data in the 3D virtual dance action standard rate data table, it can be seen that in the five dances randomly selected by the random dance teacher, each dance is divided into the starting stage, the climax stage and the ending stage. Each stage has the digital output of dance action standard rate data, which indicates that the function of dance art digitization can operate normally. Then the dance teacher made a comparative analysis between the standard dance action and the virtual 3D character dance action. This paper concluded that the virtual 3D character dance action is basically not much different from the actual standard action. This also shows that the value generated by this function is in line with the reality, and the accuracy of data output is no problem.

3.2 Music and Art Module Test

Table 2: Digital music art matching data table

	Music 1	Music 2	Music 3	Music 4	Music 5
Beginning part	99%	98%	100%	96%	100%
Climax part	98%	99%	99%	96%	100%
Ending part	97%	94%	98%	96%	100%
Mean	98%	97%	99%	96%	100%

The most direct way to check whether the music art module is in good operation is to check whether the recognition and matching degree of its music hardware device to music songs is high.

The higher the matching similarity of music spectrum, the higher the digital conversion rate of music notes in the music art module, and the higher the digital music integrity rate. Several music songs are randomly selected for this test, and each song is the beginning part, the climax part and the end part. The digital music art matching data table is shown in Table 2:

According to the matching data in the digital music art matching data table in Table 2, people can determine the digital transformation of original music. All the tested music has been effectively transformed and the matching data has been produced, which indicates that the music art module function can operate normally. Secondly, the accuracy of the data is tested. According to the comparison between the converted digital audio and the original audio, there is basically no obvious difference in human hearing, which indicates that the data is true and effective. The reason why most of the music matching data in the data does not reach 100% is that it cannot be detected according to the existing technical level of the experiment, but this problem would not affect the experimental results.

3.3 Image Art Module Test

The key and difficult point of image art digitization mainly lies in the grayscale processing of the image. The grayscale processing of image data is related to the color quality of the image art works generated by the system. The smaller the difference between the gray values of the image, the weaker the system's ability to separate the color areas of the image, thus affecting the ability to control the image boundary. This may eventually lead to chaos in the boundaries of the overall digital art image. The data that can most intuitively reflect the image gray processing is the image recognition rate. The higher the image recognition rate, the more complete the image is analyzed by the system, and the more obvious the gray value difference would be. Through testing several groups of image art modules, the data table of art image recognition rate is shown in Table 3:

Table 3: Data table of art image recognition rate

	Group 1	Group 2	Group 3	Group 4	Group 5
Picture 1	85%	90%	88%	95%	100%
Picture 2	87%	85%	89%	98%	100%
Picture 3	89%	80%	90%	95%	100%
Mean	87%	85%	89%	96%	100%

From the data in the art image recognition rate data table in Table 3, it can be intuitively understood that in the five groups of image data, the recognition rate of most image data is between 80% and 90%, and only a small part is above 90%. According to the data produced in the art image recognition rate data table, at least the image art module has no problems in system operation and data output. Secondly, because of the conceptual and non-quantifiable nature of image art, it is difficult to judge and analyze the image recognition rate data. In order to solve this problem, the fifth group of data is specially added in this test. The fifth group of image data is monochromatic image. Its purpose is to detect whether the system recognition is effective. If the result is 100%, it can be determined that the recognition system functions normally; If the result is not 100%, there is a problem with the system. According to the test results of the fifth group of data, the system functions normally and the first four groups of image recognition rate data are accurate and effective.

3.4 Human-computer Interaction and Digital Art Classification Test

After confirming the normal operation of several functions of the main body of the system, it is necessary to test the system framework functions and auxiliary functions, that is, the classification

of human-computer interaction interface and digital art system. The main functions of human-computer interaction interface include user guidance, music, dance, painting and data classification, among which music, dance and painting have internal subordinate parts. The following is the operation flow chart of human-computer interactive virtual digital art system, as shown in Figure 2:

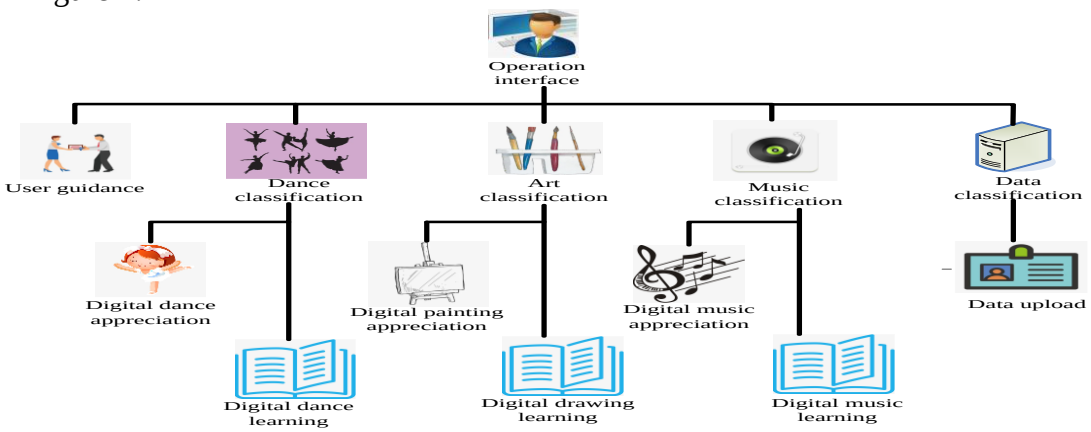

Figure 2: Operation flow chart of human-computer interactive virtual digital art system

The test team members clicked and used all interfaces of the human-computer interaction system. According to the use results, the overall framework of the human-computer interactive virtual digital art system is complete, and there is no unusable or error in each unit interface. The test team members also uploaded some data on the auxiliary function, namely the classification function of the digital art system. According to the upload results, the system classifies the uploaded data by artificial intelligence, and the classification accuracy reaches 100%. Through the classification test of human-computer interaction interface and digital art system, the final result proves that the framework of the system on the operation interface is complete and can be used normally.

4. Comparative Analysis of Various Data of Digital Art and Traditional Art

No matter what form art exists, its main role is to provide people with appreciation and learning. If no one appreciates and learns any art, it is not called art [14]. As an art form emerging in recent years, digital virtual art has innovated traditional art forms on the premise of inheriting traditional art, injecting fresh blood into the development of art [15]. In order to verify the difference between the digital art human-computer interaction system and the traditional art form, this paper compares and analyzes the digital art and the traditional art data from several aspects, and judges the advantages and disadvantages of the two methods by analyzing the data.

4.1 Comparison of Dance Art Learning Efficiency Data

As a form of body art, dance art has always been loved by artists for its elegance. However, the learning of dance is an extremely long and painful process for trainers. In addition to their strong willpower, there are many other objective factors that would affect the learning efficiency of dance. The following is the training data of a dancer using two different training methods to train two dances of the same type for many times [16]. The comparative analysis diagram of standard rate and time efficiency of dance training is shown in Figure 3: (a represents the comparative diagram of standard rate of dance training, and b represents the comparative diagram of time efficiency of dance training).

From the comparative analysis of the standard rate of dance training and time efficiency in

Figure 3, people can see that the trend of the standard rate of digital dance art learning is higher than that of traditional dance art in terms of the standard degree of dance learning. The time spent on dance learning is lower than that spent on traditional dance learning. According to the data in the comparative analysis chart, it can be intuitively understood that the minimum standard rate of digital dance art movement training is 50%, the maximum value is 100%, and the standard rate would eventually increase by 50%. On the contrary, the standard rate of traditional dance art movement training was 50% at the lowest and 72% at the highest, and the standard rate was eventually increased by 22%. The maximum duration of digital dance art movement training is 15 seconds, and the minimum duration is 5 seconds. The training time is finally shortened by 10 seconds. The maximum duration of traditional dance art movement training is 15 seconds, and the minimum duration is 8 seconds. The training time is finally shortened by 7 seconds. It can be seen from the data that the digital dance art training teaching is superior to the traditional dance training teaching in terms of training standard rate and training time. This is a new breakthrough and development in the training and teaching of dance art.

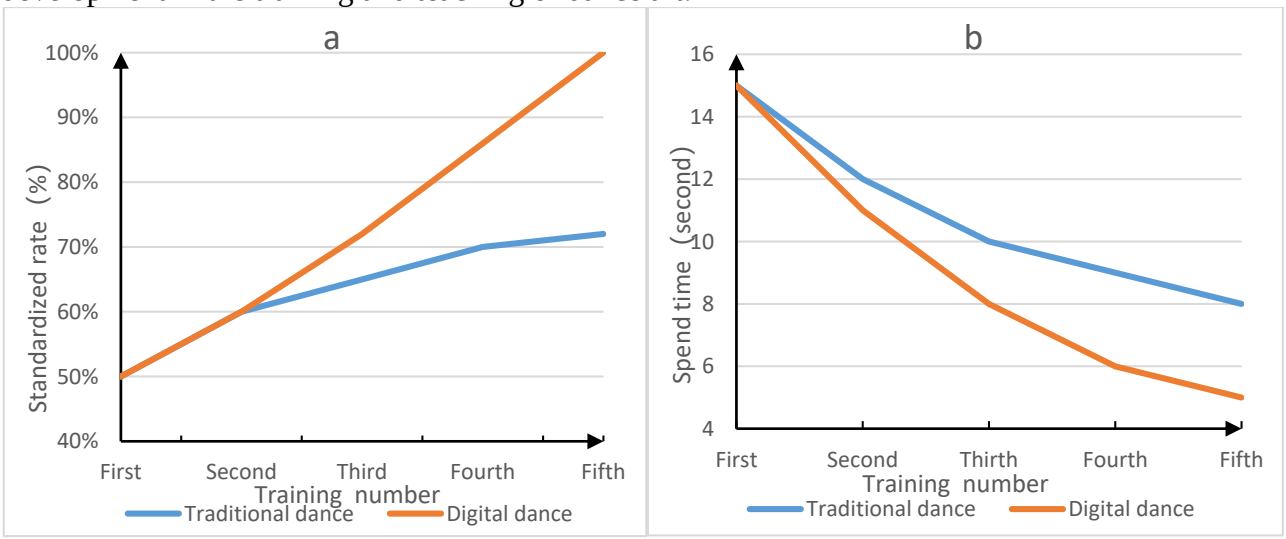

Figure 3: Comparative analysis of standard rate and time efficiency of dance training

4.2 Comparison of Music Art Storage and Learning Data

According to the current development of the field of music art, the current storage form of music art is mainly to record and store music art in the form of paper music score. This method not only has great storage risk, but also is difficult to find.

For music art learners, they also need to spend a lot of time and energy to get familiar with the corresponding tones of music scores. The music art module of digital art human-computer interaction system can effectively solve such problems. The following is a comparative analysis chart of music method usage data collected according to two different music forms, as shown in Figure 4: (a is a comparative chart of music art storage and search data, and b is a comparative chart of music art learning efficiency).

According to the data in the comparative analysis chart of the music method used in Figure 4, it can be seen that the traditional music information storage method is not as good as the digital music information storage method in terms of the storage and search of music information. The minimum efficiency of traditional music information storage is 70%, the maximum is 82%, and the storage difference is 12%. The minimum efficiency of traditional music information search is 69%, the maximum is 76%, and the search difference is 7%. The minimum efficiency of digital music information storage is 95%, the maximum is 99%, and the storage difference is 4%. The minimum

efficiency of digital music search is 96%, the maximum value is 99%, and the search difference is 3%. From the music information storage data, people can see that the overall data of digital music is more than 95%. The main reason is that music is converted into digital music art music spectrum data that can be recognized by the machine through computer hardware equipment. The storage and search of data depends on the high performance operation of the computer and the security of the replicable backup, which makes its ability far exceed the traditional way.

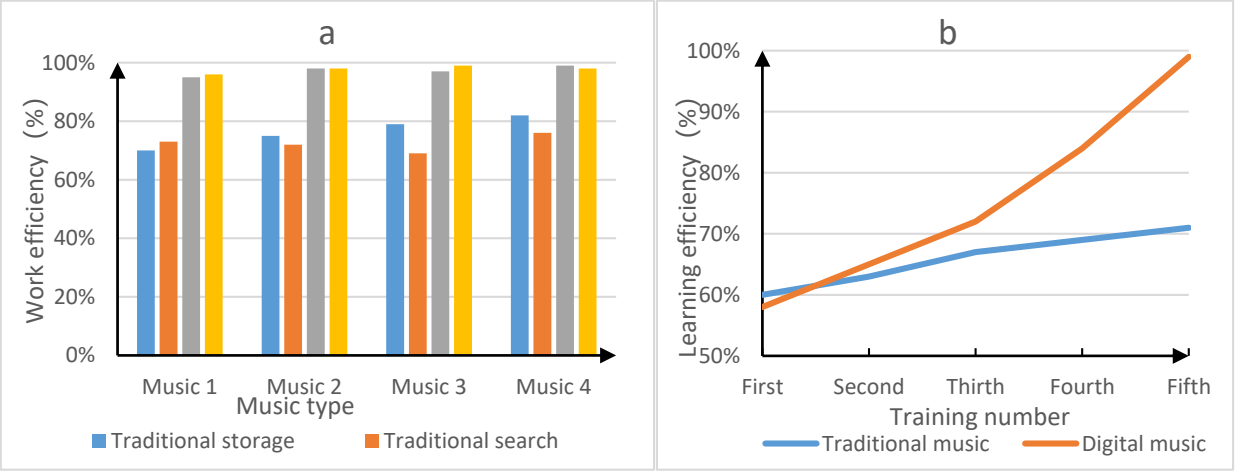

Figure 4: Comparative analysis of music method use data

Through the comparison of learning efficiency of music art in Figure b, people can see that the data trend of learning efficiency of digital music art is significantly higher than that of traditional music art. The minimum and maximum learning efficiency of digital music and art is 58% and 99%, and the music learning efficiency has increased by 41%. The lowest value of learning efficiency of traditional music and art is 60%, and the highest value is 71%. The improvement of learning efficiency of music is far less obvious than that of digital art learning, with only an increase of 11%. From the data of music and art learning efficiency, it can be found that digital music and art learning education can help students master the music knowledge they have learned faster. This is also a new attempt to traditional music education, and the resulting data is satisfactory.

4.3 Comparison of Image Art Painting Data

Through the data collection of the image art section of the digital art human-computer interaction system, people have to sigh at the power of artificial intelligence, and the production capacity of the machine is beyond human reach. In order to understand how efficient the image art painting function of the digital art human-computer interaction system is, this paper selects several pictures. Several different types of paintings can be drawn by the digital art human-computer interaction system and human painters. The following is the data table of the time spent by the digital art human-computer interaction system and human painters' paintings, as shown in Table 4:

Table 4: Data of time spent on painting works

	Digital painting(second)			Traditional painting(hour)		
Type	Oil painting	Line drawing	Watercolour	Oil painting	Line drawing	Watercolour
Picture 1	10	8	8	10	4	8
Picture 2	16	6	9	9	3	8
Picture 3	13	4	10	11	2	8
Mean	13	6	9	10	3	8

The difference between the two methods of painting time consumption data seems to be small in terms of intuitive figures, but the time units used are completely different. The time spent in digital painting is calculated in seconds, while in manual painting, the reference unit is the hour. The difference between them is more than 100 times, and some even more than 1000 times. The highest type of digital painting is oil painting, which takes an average time of 13 seconds, and the lowest type is sketch. The average time spent was 6 seconds. The highest type of traditional manual painting is oil painting, which takes an average time of 10 hours. The lowest type is sketch, which takes an average of 3 hours. The result of the data shows that in the art of painting, digital painting completely surpasses traditional manual painting. While inheriting the traditional painting elements, it has greatly improved the speed of painting creation, which has an inestimable important role in the development and inheritance of image art.

4.4 Data Investigation of Digital Art Human-computer Interaction System

According to the above comparison of several functional data, it fully shows that the human-computer interaction system of digital art is superior to traditional art in all aspects. Because of the particularity of art, digital art may not be accepted by the public. In order to confirm whether the human-computer interaction system of digital art has the function of inheriting and developing art, this paper randomly selected 100 people for data collection. The content of data collection is whether the digital art human-computer interaction system contributes to the development of art and whether the use of the digital art human-computer interaction system is satisfactory. The data acquisition diagram of the digital art human-computer interaction system is shown in Figure 5: (a is the digital art cognitive data diagram, and b is the system experience data diagram)

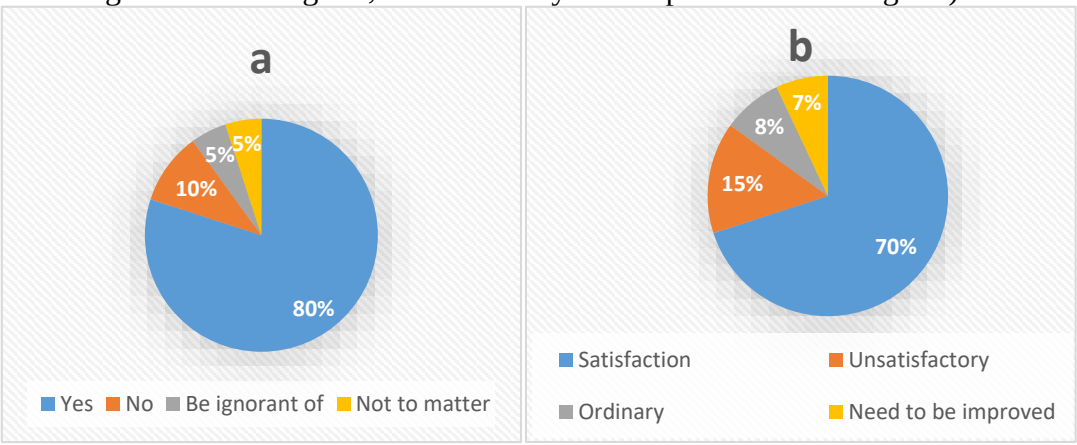

Figure 5: Data acquisition diagram of digital art human-computer interaction system

According to the data in the data collection diagram of the digital art human-computer interaction system, 80% of the people think that the digital art human-computer interaction system is the development and innovation of art, and only 10% of the people oppose this view. Opponents believe that art needs human energy and emotion to be called art. The word digital art is an insult to art. Half of the remaining 10% said that they had no concept of digital art and did not evaluate it. The other half are indifferent to art. They think that as long as they can express their own ideas, any form can be called art. In terms of satisfaction with the use of digital art human-computer interaction system, 70% of people think that the system is satisfactory, and 15% think that the system is not easy to use. 8% said that the experience of using the system was average, and 7% said that the system could be further improved to add more new functions.

5. Conclusions

As an abstract concept, it is difficult to define art, but art is everywhere. It exists in daily life and around everyone. As a new art form, digital art has appeared for a relatively short time, but it is undeniable that with the passage of time, digital art would eventually be accepted by all and become a part of the whole art. The original intention of the design of the human-computer interaction system for digital art is to inherit and develop the traditional art form and make it known and accepted in the digital field again. Although there are still some flaws and problems in the human-computer interaction system of digital art at present, in the near future, digital art would certainly lead the trend of the times and push traditional art to a new level.

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