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Research on Digitization and Diversified Cultural and Creative Design of Traditional Handicraft Elements Based on Deep Learning

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ABSTRACT

The development of digital technology provides more possibilities for the inheritance of Chinese excellent traditional handicrafts. This paper takes Chinese movable type printing as the research object, and develops and designs a user-oriented virtual experience system by combining its handicraft characteristics. In order to optimize the rendering of real-time images and video frames of the virtual scene in this system, this paper takes the deep learning oversampling algorithm as the basic framework, and uses two major types of neural network structures, namely convolutional neural network (CNN) and recurrent neural network (RNN), to carry out the rendering reconstruction, and at the same time, it uses the texture enhancement oversampling algorithm to recover the image texture details, improve the edge sharpness of the image, and comprehensively build the DLSS model. The performance of the DLSS model constructed in this paper and the virtual experience system of movable type printing is tested successively. The average score difference between the pre- and post-tests of the virtual experience system of this paper is 34.46, which is much higher than that of the traditional form of knowledge mastery of 20.76, indicating that the virtual experience system supported by this paper's algorithms can effectively carry out the inheritance of traditional handicrafts.

Keywords: dlss modeling, texture-enhanced oversampling algorithm, virtual experience system, traditional handicrafts

1. Introduction

Traditional handicrafts belong to an important part of intangible cultural heritage and play an increasingly important role in regional development, and the intangible culture they contain is

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closely related to people's lives, reflecting the unique local mode of thinking, values, cultural traditions, humanistic spirit, and the way of interaction between human beings and nature and others [1]. The sustainable development of handicrafts is important for the protection of traditional culture and the maintenance of local cultural identity. With the further development of technology and the concept of Industry 4.0, human beings are moving towards the smart era. The main purpose of Industry 4.0 is to use the IoT information system to make the manufacturing industry transform to intelligence [2]. Market demand is driving the change in production technology to some extent. Uniqueness and personalization are the inherent nature of handicrafts, including creative ideas, uniqueness, originality, etc., and the humanistic values and warmth it contains are difficult for mechanical products to have, which is also the unique living space of handicrafts [3]. Technological development is a part of the narrative in the history of the development of global handicrafts or a specific handicraft, and it is also one of the reasons why modern handicrafts are different from the handicrafts of the agricultural era. The deep integration of science and technology and culture will be an important driving force for the inheritance and development of many cultural heritages, and the use of digital technological innovation to develop cultural heritage has become the development trend of globalization, and the use of digital technology to participate in the protection of traditional NRL projects is one of the important measures and practical paths for NRL protection in the future [4]. As a typical modern technology, digitalization is increasingly important for the promotion of traditional handicrafts. Digital technology can provide some new opportunities for the protection of traditional handicrafts from different dimensions. For example, it provides a new way for the recording, display and dissemination of handicrafts, easy access to cultural resources and information of handicrafts through digital technology, and immersive handicraft experience for tourists under virtual reality technology [5]. In addition, it also provides new directions for cultural and creative design and production. For example, digital tools are very common in the contemporary design process, AutoCAD, Adobe Photoshop and other design tools to help designers better express themselves, and automatic pattern recognition and generation of technology to promote the use of traditional craft patterns, to a certain extent, to enhance the public's attention to traditional crafts [6]. Various types of science and technology can be an effective tool to revitalize traditional handicrafts, build cultural ecology, and help traditional handicrafts achieve sustainable development.

In the development of globalization today, traditional handicrafts from the beginning of the export to earn foreign exchange to solve the problem of people's survival and life to the gradual decline [7]. Literature [8] found that China pays more attention to the inheritance and protection of traditional handicrafts, while other countries pay more attention to the combination of technical products and the economic value of their products. However, with the rise of cross-cultural exchanges and cooperation, traditional handicrafts see a ray of hope again. At the same time, due to the impact of globalization and other reasons, many traditional handicrafts are threatened and lost, which is the main reason for the different emphasis between China and other countries. In terms of inheritance and protection, traditional handicrafts have experienced the publicity of traditional handmade elements in movies and television, the use of handicrafts for decoration in life, and the purchase and collection by tourists in the development of cultural and tourism industry, and most of them have been passed down in the form of family or master and apprentice, and it is difficult for the inheritance and protection to be sustained in today's social environment [9].

In the 20th century, digitalization was vigorously implemented and technology was integrated into the industry, bringing new opportunities for the inheritance and protection of traditional handicrafts, innovative design and manufacturing. Literature [10] describes that the elements of non-heritage handicrafts are embedded in cell phone applications, and at the same time, digital means are used to build a digital platform for the expression of handicrafts and cultural space, so as to realize the inheritance of non-heritage handicrafts. Literature [11] designed a paper-cutting virtual reality system supported by virtual reality technology to realize the digital protection of traditional handicrafts paper-cutting, presenting the art of paper-cutting in 3D form, and at the same time, allowing the dissemination of paper-cutting culture. Literature [12] mentions that traditional handicrafts are innovatively developed under modern computer-aided design tools and digital manufacturing, and the addition of auxiliary tools to the handmade not only accelerates the speed of production, but also lays the foundation for the design innovation of handicrafts. Literature [13] on the use of robotics in the production of embroidery handicrafts, and has been seen in mass production. And literature [14] utilizes deep learning to design pattern innovation for traditional handicrafts - rattan weaving, which starts from the customer's emotional perception and combines deep convolutional generative adversarial network to obtain creative and emotionally resonant rattan weaving patterns. Due to the many elements of traditional handicrafts, their digitization is still in the process of gradual improvement, and at the same time, the application of technology has not matured, and only large-scale production and digital protection are in the forefront. However, the sustainable development of traditional handicrafts requires a steady stream of innovative designs and long-lasting inheritance, so in-depth research in deep learning and other intelligent technologies is also needed.

In this paper, we first propose the basic components of the deep oversampling learning algorithm and its implementation of rendering optimization, and combine them with the local self-learning texture enhancement oversampling algorithm to form a DLSS model as a rendering optimization technique for real-time scenes and images. Then we take the traditional handicraft of movable type printing as an example, develop and design a multi-functional user virtual experience system by combining its cultural characteristics, and optimize the rendering of real-time scenes in the system by using the model in this paper. Finally, the validity of the model is examined through video oversampling and rendering performance, and the feasibility of the virtual experience system is examined through the comparison of user experience scores and effects.

2. DLSS model

Starting from the historical and cultural connotation of traditional handicrafts, deep learning supersampling algorithm (DLSS) technology is conducive to efficiently transforming and practicing the “living heritage” and innovative design of traditional handicrafts. As the core of DLSS technology, its neural network model realizes better image processing effect based on the combination of CNN and RNN. The front-end CNN extracts the high-level features of the image and uses RNN to combine the time-domain information, while the back-end uses a fully-connected layer to process the features extracted from the previous CNN layer to realize the classification and reconstruction of the image, and incorporates a local self-learning texture enhancement supersampling algorithm to recover the lost details of the texture of the image and to suppress the diffusion of the image edges.

2.1. Basic Components

DLSS neural networks include techniques such as distributed training, mixed precision computation, and automatic mixed precision due to the large amount of training data and computational resources required during the training process.These techniques can significantly improve the speed and efficiency of model training while ensuring the accuracy and stability of the model.The structure of the DLSS is shown in Fig. 1.

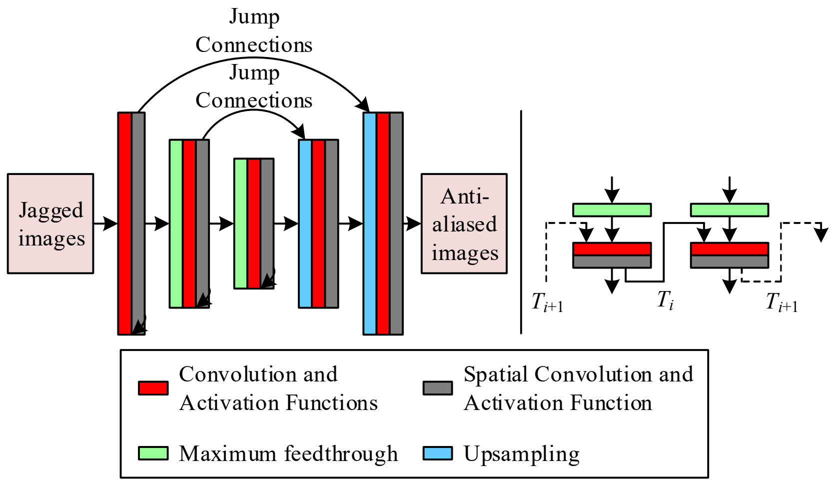


Fig. 1. DLSS neural network structure

The problem of vanishing gradients is solved as much as possible by jumping connections between layers, and for multilayer neural networks, improper activation functions can trigger the concatenation effect in the propagation of the gradient direction, which leads to the network weights not being able to be updated or being updated minimally, and the network training failing.

The DLSS neural network structure consists of multiple levels, each with a different resolution and a different feature map. Each level uses a different image pyramid to extract and combine features by downsampling and upsampling the image. This particular network structure can be considered as a deep pyramid network. Specifically, the DLSS neural network model includes the following key components:

1) Input layer: accepts the low-resolution image rendered by the engine as input.

2) Feature extraction layer: extracts features of the input image through convolution and pooling operations. These features are usually digital representations that indicate the content of the image, such as edges, colors, and textures.

3) Deep Pyramid Network: consists of multiple levels, each of which uses a different image pyramid for downsampling and upsampling to extract and combine features.

4) Up-sampling layer: up-samples the low-resolution feature maps in the pyramid network to a higher resolution. This is usually accomplished using an inverse convolution operation.

5) Feature fusion layer: fuses feature maps from different pyramid levels in order to generate richer feature representations.

6) Output layer: generates high resolution images as output. For the sampling process, the more the number of samples within a certain pixel range, the more accurate the pixel values output to the coordinates corresponding to the large resolution. However, the pixel value accuracy is only a mechanical theoretical accuracy, which does not mean that the picture is accurate, and if the sampling range is enlarged one way or another, it will lead to distortion of the picture. Therefore, in order to increase the number of samples and limit the sampling range, DLSS adds a time dimension to the spatial sampling, and samples both the current frame and the previous frames, and the range of the sampled frames will be judged by the AI by virtue of the comparison of the frame generation time and the pixel values, to make sure that the frames are suitable for inclusion in the sampling range.

2.2. Texture Enhancement Oversampling Algorithm

The framework of the local self-learning texture enhancement oversampling algorithm is divided into four main parts: chunking, localization, matching, and synthesis, and the specific flow is shown in the following:

1) The input image I_L is interpolated by the contour template to obtain the initial interpolated image I_I.

2) Extract the low frequency I_{LL} and high frequency I_{LH} of I_L.

3) Divide I_I into blocks according to the rule and the set of blocks is B.

4) Take one of the blocks $I_k \left(I_k \in B \right)$ to find a point p corresponding to I_k in I_{LL}.

5) With p as the center, perform block coarse matching in its neighborhood to find a matching block control point p_1 with the smallest total variation of a block, and with p_1 as the center, perform block fine matching in its neighborhood to find the best block matching control point p_2.

6) Using the found best block matching point p_2 as the vertex, construct a block $R\left(R \subset I_{LL} \right)$, and obtain the high frequency H_k corresponding to R through the one-to-one correspondence between low and high frequencies.

7) Stitching H_{ks} obtained by adding windows to H_k to form high-frequency information H with I_I dimensions.

8) Superimpose H onto I_I to synthesize a super-resolution image I_H with texture features of the original low-resolution image I_L.

The local self-learning texture-enhanced oversampling algorithm takes the high-frequency information of the original low-resolution image as a priori knowledge, which compensates for the lack of a priori knowledge of the DLSS image oversampling algorithm and improves the quality of the output image. Dual matching is used, which makes an effective compromise between time and matching accuracy compared to global search and small window search. The use of Gaussian function plus window simplifies the complexity of the algorithm compared to Birmingham window and filter bank. The local self-learning texture enhancement oversampling algorithm is carried out at one multiscale, the original low resolution image/high resolution image obtained by interpolation, and the effect of overlapping region can be well resolved by using Gaussian function plus window, which simplifies the complexity of the algorithm compared to the Clasner algorithm which is carried out at multiple multiscale and the Freedman algorithm which employs a Birmingham window and a filter bank.

2.2.1. Positioning. Find the control point I_k of the block $B_i\left(I_{kx}, I_{ky} \right)$ to be matched, the corresponding pixel point p on the low frequency I_{LL} of the original low resolution image I_L with coordinates $\left(p_x, p_y \right)$, calculated as in equation (1):

$$p_x = \frac{I_{kx}}{scale}, p_y = \frac{I_{ky}}{scale} \tag{1}$$

where, $scale$ is the image scaling factor see Fig. 2.

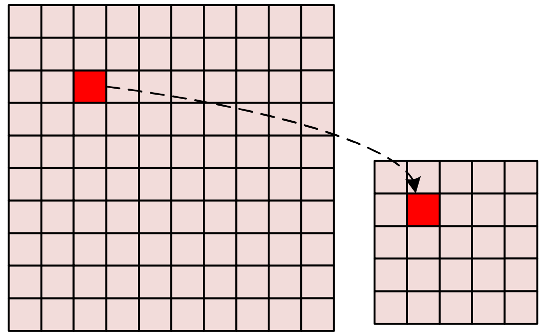


Fig. 2. Location map

Fig. 2 shows a point I_k in I_I of 10×10 in its corresponding localization point p in its corresponding I_{LL} of 5×5. Each small square represents a pixel point, where the black box on the left represents the block to be matched B_i with the black square as the vertex (I_k), and the black square on the right is the corresponding localization point p on I_{LL}. A block search range is constructed with p as the central control point.

2.2.2. Matching learning. Matching is categorized into coarse and fine matching. In the process of matching, this paper adopts the minimum of the sum of absolute values (SAD) of the difference between the pixel values of the corresponding points of two blocks as the matching criterion. In the search range (here is the region of 5×5), the "X" type search is used to find 4 pixel points to be matched as the control points to construct blocks, corresponding to a total of 4 blocks. These 4 blocks are matched with B_i in turn, and the control point p_1 of the coarse matching block is obtained under the matching criterion, and the coarse matching is completed.

Then fine matching is performed by constructing another block search range (here the region of 3×3) with the coarse matching block control point p_1 as the center point, and constructing blocks from each pixel point within the search range as a control point to obtain the best matching block with p_2 as the control point $R = B_i\left(p_{2x}, p_{2y}\right)$. The Glasner algorithm uses nearest-neighbor search for matching, and the Freedman algorithm performs global matching within a restricted small window. The local self-learning texture-enhanced oversampling algorithm performs multiple matches on a single scale, with the interpolated image and the original image providing the sample and learning blocks.Both the Freedman algorithm and the Glasner algorithm downsample the original image to obtain a series of low-resolution images at different scales, with the original image and its downsampled images providing the sample and learning blocks, while the local self-learning texture enhancement oversampling algorithm makes more use of the original image information and is relatively more concise.

2.2.3. Window addition and synthesis. The texture features of an image are often reflected in its high frequency part, in order to recover the texture of the oversampled image I_I, it is necessary to add the high frequency information of the original low resolution image I_L to I_I in some form.

Compared with Freedman's algorithm, which takes simple grayscale information as high-frequency features, the high-frequency information obtained by Gaussian convolution is more effective.The premise of Freedman's algorithm is that all high-frequency information will be lost after the image is downsampled first, and then upsampled and returned, which is only an ideal situation. The Gaussian fuzzy high-frequency information can be extracted as long as the parameters are optimized. Compared with Freedman's algorithm, the algorithm in this paper is more accurate in finding high frequencies, and other parts that do not belong to high frequencies are eliminated more cleanly.

In the above section, we find the best matching block of the super-resolution image to be matched in block $B_i\left(B_i \subset I_I\right)$ in block I_{LL} in block R. By the one-to-one relationship between the low-frequency information and high-frequency information, we get the high-frequency information corresponding to the best matching block R in block I_{LH} in block H_k can not simply be added to I_I, and it is necessary to carry out a windowing process. This algorithm in the original low-resolution image interpolation obtained from the high-resolution image of this a multi-scale, compared to the multi-scale image in the algorithm, the overlap area is not much influence and overlap is not high, and high-frequency part of the algorithm in this paper to extract the more accurate, so the algorithm uses a Gaussian function will be able to inhibit the impact of overlap area. H_k After adding the window is obtained H_{ks} as in equation (2):

$$H_{ks} = H_k G_\sigma\left(\left\|x - x_c\right\|\right) \tag{2}$$

where $G_\sigma\left(\left\|x - x_c\right\|\right) = \frac{1}{2\pi\sigma^2} e^{-\frac{\left\|x-x_c\right\|^2}{2\sigma^2}}$ is the Gaussian window function.

Finally, all the estimated high-frequency information blocks are spliced to obtain H, which is synthesized with I_I to obtain the super-resolution image I_H as in equation (3):

$$I_H = I_I + H \tag{3}$$

This chapter focuses on the neural network structure and key features of the Deep Learning Supersampling Algorithm (DLSS), using its neural network model as a model framework. Combined with the local self-learning image texture enhancement supersampling algorithm, the texture details of the interpolated image are recovered using local similarity to improve the quality of the output image. The DLSS model is thus constructed as a rendering optimization technique for the traditional handicraft virtual experience system in this paper.

3. Innovative design of traditional handicraft elements

The use of deep learning oversampling technology and related optimized rendering algorithms to support the innovative design of traditional handicrafts is of epochal importance for the living heritage of traditional handicrafts. Traditional handicrafts are formed and developed in a specific cultural ecological environment, so the living heritage will protect and promote the skills and cultural connotations of traditional handicrafts, but also promote the sustainable development of traditional handicraft industry. In view of the rapid development of new media technology and other science and technology, it has become a new demand for better living heritage and innovative design of traditional handicrafts by combining relevant digital technology. This chapter takes movable type printing as an example to develop the innovative design based on the model of this paper.

By examining the historical characteristics of movable type printing, as well as analyzing the feasibility of innovative design and researching the design strategy, this chapter completes the development of a user-based virtual scene experience system for movable type printing through specific design practice based on the DLSS model. According to the pre-design strategy, it mainly includes three major steps: virtual scene construction, interactive function implementation and rendering output optimization.

3.1. Experience flow design

In order to help users have a global understanding of the culture of movable type printing, a systematic guide experience process is set up in the experience process, which is guided and designed according to the order of the process of the cultural art of movable type printing, so that the users can try to experience the process according to the actual process, and really recognize the craft of movable type printing.

3.2. Introduction to the main interactive functions

The virtual experience system of movable type printing culture utilizes virtual reality technology to build an interactive three-dimensional virtual scene, which is able to reproduce the historical scene of movable type printing culture in an all-round and multi-sensory way, and allows users to interact with the scene elements in addition to trying an immersive roaming experience. Throughout the interaction process, users are able to experience multi-sensory feedback.

Based on the experience process, the main interactive functions of the virtual experience system are summarized as follows:

1) Virtual scene roaming. Based on the historical scene of the cultural production of movable type printing, the virtual system of movable type printing is built. When roaming in the virtual scene, users can choose to follow the scene guide instructions or walk around freely without system control, giving users the greatest freedom of roaming.

2) Multi-sensory interactive feedback. A variety of sensory feedback forms are set up in the virtual scene. In addition to the ability to interact with scene elements through clicking and other common operating methods, through voice messages, environmental sounds, specific object sound design to achieve sound changes, word mold polishing area and engraving area odor feedback can change according to the user's real-time position, giving the user timely multi-level feedback.

3) Interface introduction and interface game interaction. Since the virtual experience scene of movable type printing culture includes 4 scenarios and 20 engraving processes, the tour experience process is long. It is difficult to maintain the users' interest in the tour by simply roaming around the scene, so it is necessary to set up cultural knowledge boards and playable games to enhance the users' participation in the tour process. The cultural knowledge board belongs to the information output, which is not difficult, and it appears several times in the whole experience process in the form of interface explanation, which can enhance the users' satisfaction in learning knowledge. The playable games appear in the way of interface game interaction and have a certain degree of difficulty. Appropriate difficulty can enhance the immersion of the tour, but the repeated appearance of difficult games during the tour will weaken the interest of users, so it is not appropriate to set up high difficulty games several times during the tour.

The frequency of interface explanation and interface interactive games is set according to the experience flow of movable-type printing culture, and the interface interactive games include the raw material cutting game in the polishing partition and the anti-writing game in the engraving partition.

3.3. Real-time rendering of models

Rendering is a branch of the field of graphics that focuses on the process of mapping three-dimensional data to a two-dimensional image, simulating the functions of the camera and the eye in real life. From a physical point of view, light is emitted by a light source, and after various physical phenomena such as refraction and reflection occur in space, it maps objects in the outside world onto the retina and film, which are transformed into images after entering the imaging plane. It can be seen that rendering can be summarized as a computer simulation of behavior with light source, scene, and camera as the main objects of study and optical physics as the theoretical basis.

In order to simulate the behavior to get a sufficiently approximate result while ensuring a suitable overhead, some simplification of the light source, camera, and scene is first required.

1) Simplification of the camera. Analyzing the principle of imaging from the human eye, light enters the retina through the pupil and is transmitted to the brain by tens of millions of light-sensitive neurons behind the retina. After simplification, the combination of neurons and retina can be transformed into a two-dimensional matrix called an image. The two axes of the image matrix are width and height. Each data cell within the matrix, then, simulates the optical information recorded by the neuron at that location, called a pixel. The process of solving the image is the process of solving for each pixel at a particular light source and scene characterized by the position and angle of the light incident on the pixel, by solving for all the pixels, a complete image can be obtained.

2) Simplification of the scene. Since real world objects are very complex, in graphics, real objects are generally decomposed into two parts: model and material. The model determines the overall outline of the object at the macro level, while the material summarizes the detailed information of the object at the micro level, the simplification of model and material is shown in the following:

(1) Simplification of models. Current real-time rendering applications, due to the limitations of computer storage capacity, should use as little information as possible to generalize high-precision shape features, for regular objects and their combinations, such as spheres, fractals, etc., can be generalized with formulas and parameters. And most of the real objects are irregular objects, which are generally summarized using mesh, point cloud or body data.

(2) Simplification of the material. For the more detailed parts, such as small bumps on the surface of the object, color and roughness, etc., are part of the material. Even the distribution of micro-surface bumps, the degree of electromagnetic wave absorption and perturbation caused by different material media and the degree of refraction, scattering, reflection, anisotropy and transparency and other related optical phenomena, are uniformly subsumed into the material.

This chapter combines the cultural connotation of Chinese movable type printing with the user experience process, which consists of a virtual experience system with virtual scene roaming, multi-sensory interaction feedback, interface introduction and interface game interaction. For the image rendering and video frame rendering involved in the experience system, a real-time rendering model is constructed and the rendering effect is optimized with the technical support of the DLSS model in this paper.

4. Performance test of the virtual experience system

In order to verify the practical effect of the virtual experience system of movable type printing proposed in Chapter 3 in application, this chapter tests and analyzes the DLSS model and the virtual experience system respectively. For the performance of the DLSS model in the virtual experience system, this paper tests the oversampling effect and rendering effect of the optimized video presentation. For the usability of the virtual experience system of movable type printing, this paper analyzes it from the perspectives of user experience score and user experience effect.

4.1. Performance analysis and testing of DLSS models

4.1.1. Oversampling effects on video. In order to better reflect the actual effect of video oversampling in the virtual experience system, this paper randomly selects the video with a duration of 20s in the experience system for the comparison based on the peak signal-to-noise ratio (PSNR), which is one of the most widely used image evaluation metrics, and measures the quality enhancement brought by image reconstruction by the ratio of the signal peak to the background noise.

In this paper, the PSNR is calculated by taking the average value of every 500 frames, Figure 3 shows the comparison of PSNR before and after video supersampling: according to the average calculation of the PSNR enhancement ratio of the supersampling result of each frame, the PSNR of the video after supersampling is improved by about 17.8% on average compared to the original low resolution video, and synthesizing the above test results, the DLSS model of this paper The video supersampling function realized in this paper can well improve the quality of low quality video, and at the same time make the picture have better visual effect.

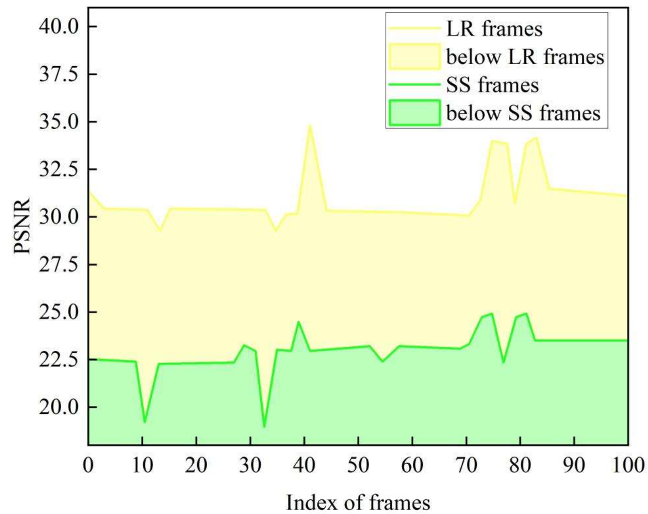


Fig. 3. PSNR curves of video frames before and after oversampling

Also in this paper, the speed of processing image frames is tested, since the processing speed has stabilized by most of the time in the middle, the single frame processing time of the first 100 images is taken here, and the results are shown in Fig. 4.

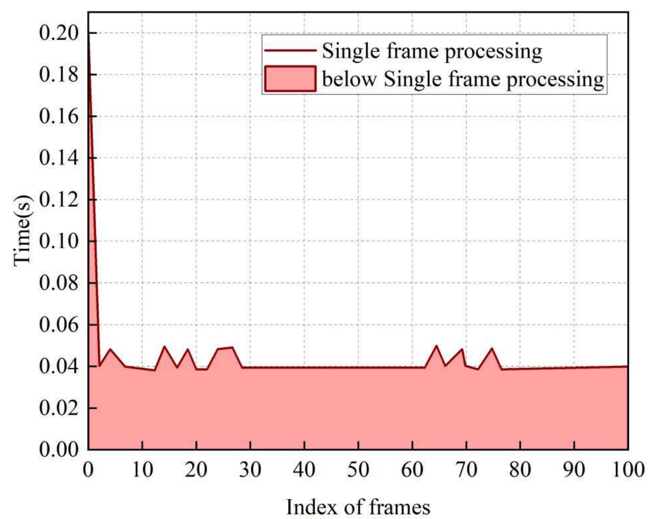


Fig. 4. The processing time of a single frame of video

Except for the process of model loading which took some time at the beginning, the processing time of a single frame in the subsequent image frame processing has been kept stable in the interval of 0.04s to 0.05s. The actual results show that the DLSS model in this paper can improve the video image to some extent, and the processing speed of single-frame image is basically kept in the millisecond level.

4.1.2. Rendering performance. In this paper, we simulate the large-scale 3D interactive scene screen of movable type printing press by randomly replicating the experimental model, the number of replications are 100, 150, 300, 600, respectively, and the rendering is carried out by using the triangular mesh model, the parametric model and the model of this paper under different number levels, the corresponding frame rate can reflect the rendering performance of different methods, the experimental results are shown in Fig. 5.

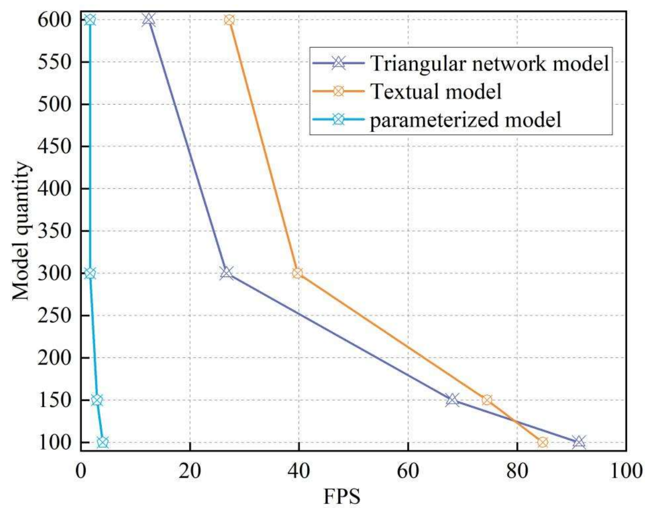


Fig. 5. Rendering performance comparison

From the experimental results, the model in this paper has a more obvious advantage in the face of large-scale 3D interactive scene screen rendering of movable type printing. The frame rate of the parametric model in the large-scale 3D scene screen is basically below 2, and there is no real-time interactivity at all. When the number of scene models reaches 300, the frame rate of BIM visualization based on triangular mesh model drops to below 30, which produces lag and delay in real-time rendering. When the number of models in the scene reaches 600, the frame rate of model rendering drops to below 30, but the model in this paper has better rendering performance than the triangular mesh model in general, and basically preserves real-time interactivity. When facing small-scale 3D models, the triangular mesh model has slightly better rendering performance, mainly due to the fact that when the amount of data is small, the triangular mesh model performs better because it has fewer vertex-related computations in the graph rendering pipeline, and the complexity of the shading computation is lower than that of the method in this paper. However, when the model complexity increases, since the model in this paper does not need vertex-related computation, it can obtain a larger performance improvement and meet the rendering optimization requirements of the virtual experience system of movable type printing arts.

4.2. Usability testing of virtual experience systems

4.2.1. User experience scores for the interaction process. Since the pre-interaction stage is the key stage for users to perceive the body and the virtual environment, and to familiarize themselves with the interaction environment and process, the testing process of the virtual experience system is targeted at the first learning experience of the movable type printing process. In this paper, 15 users are selected, all of them are sophomore undergraduate students from the design school of a university. Each user is required to have a learning experience of 4∼5 minutes for each of the three different interaction functions proposed in Chapter 3: virtual scene roaming, multi-sensory interaction feedback, interface introduction and interface game, and the interval between the experiences of each interaction function is 7 days.

After each experience, users were asked to score on a 5-point Likert scale ranging from “Strongly Disagree”, “Disagree”, and “Not Really”, The scale ranges from “strongly disagree”, “disagree”, “don't agree”, “not necessarily”, “agree” to “strongly disagree” with scores of 1, 2, 3, 4 and 5 in that order. The following 10 questions were set for ease of use, validity, and satisfaction:

(Q1) Route and interaction guidance in the virtual system was clear.

(Q2) The way of operation is simple and there is no need to pay too much attention to the interaction cues in the virtual environment.

(Q3) I think the execution of interactive actions such as cutting and writing is smooth.

(Q4) This experiential system presents a wealth of knowledge about movable type.

(Q5) This experience allowed me to make and learn about movable type with my own hands in a short period of time.

(Q6)I can experience the fascination of the culture of movable type printing press during the operation.

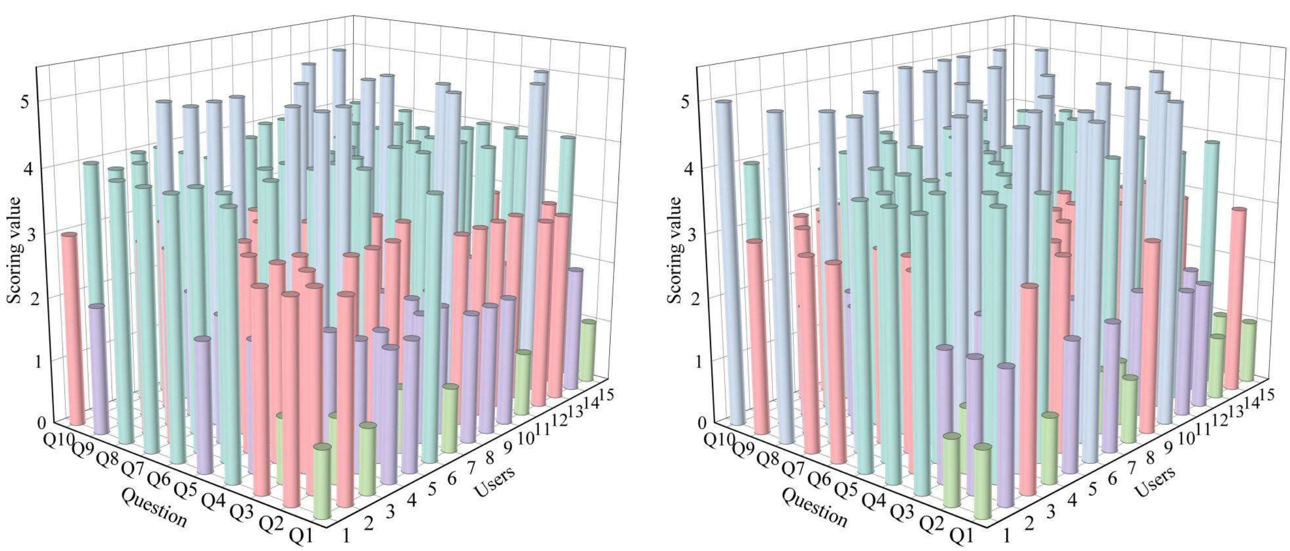
(Q7)I think this is a more effective way of experiencing the art than the traditional exhibition format.

(Q8)This type of interactive experience enhances my sense of participation and interest in learning.

(Q9)After the experience, I can form a reflection on the cultural creativity of movable type printing.

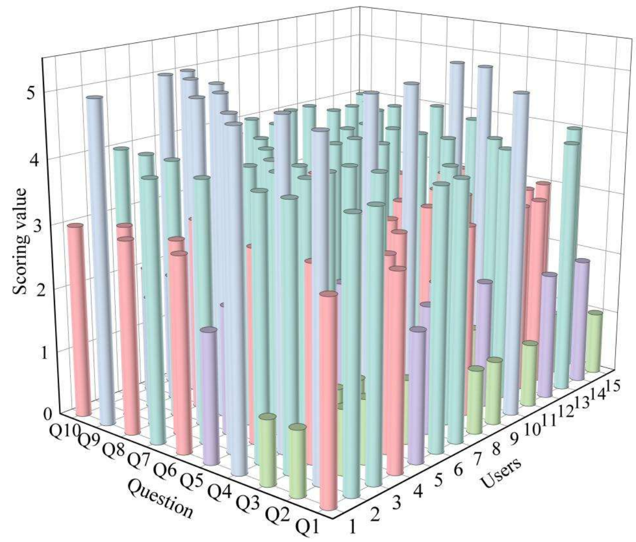
(Q10)After completing the interactive experience task, I would like to continue to create in this experience.

The ratings of the 15 users for the three functions of the virtual experience system are shown in Figure 6, from which it can be seen that some users hold a “strongly disagree” attitude towards the ease of use of the system, while most of them hold a positive view on the effectiveness and satisfaction of the system, i.e., there is still room for improvement for the operation and use of the virtual experience system designed in this paper, which is excellent for the innovation and development of traditional handicrafts. This means that the virtual experience system designed in this paper has room for improvement in operation and use, and is excellent in the innovation and development of traditional handicrafts.



(a) 15 user ratings of Feature 1

(b) 15 user ratings of Feature 2



(c) 15 user ratings of Feature 2

Fig. 6. A total of 15 valid scores were collecte

Table 1 presents the mean and standard deviation of user scores for the three different interaction features. By comparing the user scores on the three dimensions of ease of use, effectiveness, and satisfaction across the three sets of interaction features, it can be seen that the mean value of the interaction feature “Multi-sensory interactive feedback” is larger than the other two interaction features in most of the questions. Through a longitudinal comparison of the 10 questions, it can be seen that question (1), “The routes and interactions in the virtual system are clear,” has the lowest score, with an average value of less than 3 in all three groups. In addition, the standard deviations of the virtual scene roaming and multi-sensory interaction feedback were high in most cases, indicating an implicit bias in the user's familiarity and cognitive basis for these two forms of interaction.

Table 1. The scores of the three groups of interaction forms

serial number	Sample size	average value	standard deviation
		One set/two sets/three sets	One set/two sets/three sets
1	15	2/2.27/2.73	0.719/0.628/0.701
2	15	2.67/2.93/2.53	0.965/0.735/0.701
3	15	2.87/2.87/2.4	0.538/0.701/0.454
4	15	3.53/3.8/4	0.807/0.764/0.717
5	15	3.8/3.47/3.53	0.956/0.617/0.956
6	15	3.53/3.33/3.27	0.764/0.701/1.134
7	15	3.67/3.4/3.47	0.617/0.574/0.598
8	15	3.2/3.4/3.27	0.617/0.615/0.619
9	15	3.2/3.8/3.6	1.021/0.719/0.992
10	15	3.33/3.87/3.6	0.874/0.721/0.965

4.2.2. Comparison of effectiveness with traditional learning methods. In order to test the positive effect of the virtual experience system of movable type on users' perception, this paper tested the experimental group (virtual experience system of movable type) and the control group (exhibition area of movable type) using the questionnaire before and after the users' learning experience, respectively. The questions in the questionnaire address the knowledge of movable type printing arts corresponding to the perception and behavioral levels, with 5 questions in each part and 10 points for each question, for a total of 10 questions and 100 points.

1) Experimental Group. Unlike the 15 users in the previous usability test, this experiment additionally selected 15 users who participated in the study of movable type printing and conducted a knowledge assessment of movable type printing (pre-test) before they experienced the virtual experience system of this paper. They were divided into three groups according to the way of five randomly assigned teams, and participated in the experience of the virtual experience system of movable type printing at different times. During the learning experience stage using virtual reality equipment, each person had 30~35 minutes to learn and experience, and other users in the same group could observe the perspective of the user who was experiencing through the display screen. When the learners in each group had finished the experience, the knowledge assessment (post-test) was conducted again. In this test, due to time conflicts and other objective factors, one user was not able to participate in the post-test stage, and a total of 14 valid questionnaires were collected, and the results of the pre-test and post-test of the students in the experimental group are shown in Table 2.

Table 2. Knowledge evaluation score situation

serial number	Have no foundation	Before test	After test	score gap
1	2	50	75	25
2	2	70	95	25
3	2	35	85	50
4	2	40	90	50
5	2	55	95	40
6	2	30	80	50
7	2	35	75	40
8	2	45	95	50
9	2	25	65	40
10	2	30	80	50
11	2	50	95	45
12	2	55	100	45
13	2	35	75	40
14	2	40	95	55
average score	—	42.5	85.71	—
standard deviation	—	10.01912	9.69397	—

For the 28 valid questionnaires collected, they were divided into two groups of data, the pre-test and post-test, and the paired samples t-test differences are shown in Table 3. From Table 3, it can be seen that the mean score of users in the pre-test was 46.79, and in the post-test, the mean score difference between the pre and post-tests was 34.46 and showed a highly significant difference at the level of 0.01 ($t = -15.339$, $P<0.01$). It can be concluded that the immersive virtual reality embodied interactive learning experience of movable type helps the user to perceive the perceptual and behavioral levels of cognition and has a significant effect.

Table 3. T-test scores of paired samples(Experimental group)

Test	Before test	After test
Average value	42.5	85.71
Average difference	43.21	
Standard deviation	10.02	9.69
T-Stat	-15.339	
P	0.000	

2) Control Group. The control group was a single-person experience in the "movable-type printing arts exhibition area". In order to control the consistency of other variables, 15 participants in the control group were also selected to learn the art of movable type printing and divided into three groups of five. The 15 users' knowledge was pretested and posttested in the same way, and the results of the paired-samples t-test for the pretest and posttest are shown in Figure 7.

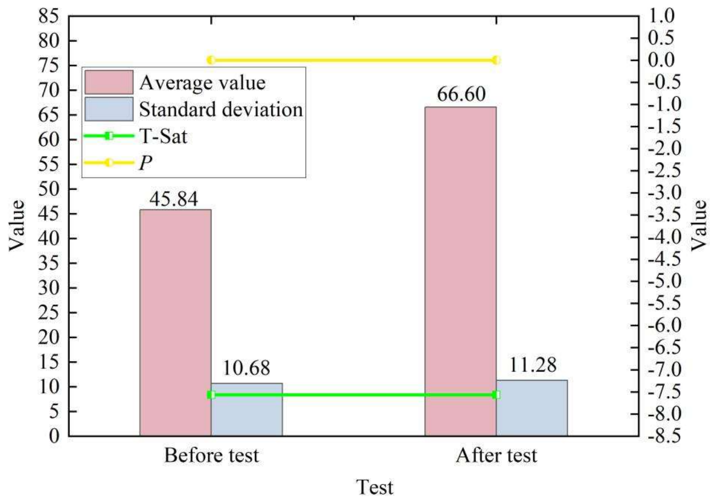


Fig. 7. T-test scores of paired samples(Control group)

As can be seen in Figure 7, the mean score of users in the pre-test was 45.84 and the mean score in the post-test was 66.60, with a difference of 20.76 between the mean scores of the pre and post-tests, and showing a highly significant at the 0.001 level (t=-15.339, P<0.01).

By comparing the pre and post-test performance of the experimental group and the control group, it can be seen that in the two groups of experiments, which also show a 0.01 level of extreme significance, the difference between the pre-test values of the users' knowledge level of movable type and printing arts in the experimental group and the control group is not much, while the difference between the mean values of the pre and post-tests is 34.46 and 20.76 respectively, which leads to the conclusion that the movable type virtual experience system is more capable of improving the users' cognitive level of movable type printing arts and has a better learning effect.

5. Conclusion

This paper constructs a DLSS model based on deep learning oversampling algorithm, improves and optimizes the color parameters such as real-time rendering in the virtual experience system of traditional handicrafts, enhances the real-time rendering effect of the system, and promotes the traditional handicrafts to better adapt to the digital era.

In the rendering performance test of the DLSS model, the PSNR of the video after oversampling is improved by about 17.8% on average compared with the original low-resolution video. In the comparison between the virtual experience system of movable type printing and the traditional exhibition form, the difference between the before and after scores of the virtual experience system users' knowledge of movable type printing is as high as 34.46, with P=0.001<0.01 being highly significant. The experimental results prove that the DLSS model constructed in this paper has a significant effect on the optimization of the rendering frame rate of the real-time interactive scene screen, and the virtual experience system optimized by using the model technology in this paper has a better role in promoting the user's cognitive enhancement, which verifies the feasibility and validity of the deep learning supersampling algorithm in the inheritance and innovation of the traditional handicrafts development.

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