

## Research Article

# Application and Practice of 2D Animation in Chinese Traditional Elements Based on Deep Learning Model

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With the progress and development of science and technology, the development of the animation industry is also rapidly accelerating. The animation industry has an inseparable relationship with the development of computers. Chinese animation originated in the 1920s. Although after so many years of precipitation, there have been some excellent animation works rich in national characteristics and national culture in China, but Chinese animation still lacks professional talents and has a poor creative environment. The problem cannot leave a deep impact on people. China has a long history. How to perfectly combine traditional Chinese elements with animation production and develop our own national characteristics through animation is a problem we have to consider. The article introduces the background of animation development, describes how to combine traditional Chinese elements with animation production, and solves the problems of rough picture quality and high collision rate in animation production. The research results of the article show the following: (1) the detail roughness of the 7 traditional element animation scenes of the 2D animation system proposed in the article has been kept below 2%, and the image quality clarity is higher than 99%, which is the performance of the 3 systems. The highest one can also show that the system proposed in the article has the best control effect for different animation scene details. The 2D animation system proposed in the article presents a steady trend of fluctuations in the dynamic light and shadow of the scene details of the 7 traditional element animations, with good detail connectivity, and the system proposed in the article occupies the least memory and has the highest stability. (2) The waiting time of the 2D animation system is the lowest among the three systems. Only in a few cases, it needs to wait for 1 s, and the rest of the animation scenes are not delayed. The dynamic animation interaction system and the real-time character animation system have poor real-time operation, and there is a certain delay. The number of collisions of the 2D animation system is the least, almost negligible. Both the dynamic animation interaction system and the real-time character animation system have a certain degree of collision. The distortion rate of the 2D animation system is generally low and will not increase with the number of experiments. However, the other two systems have higher animation distortion rates, which cannot meet the needs of animation production.

## 1. Introduction

Today, we are in an era of informationization and intelligence. With the development of science and technology, the world has entered an era of rapid development of scientific and technological knowledge. Animation technology has also been combined with computer technology. A highly automated animation production technology has gradually replaced the work of an artist. No matter how the times develop and progress, Chinese traditional culture should

not be forgotten by people. The animation industry is also a cultural industry and one of the most popular rising stars. After research, it is found that Chinese animation started late. How to combine traditional Chinese elements with animation and develop one's own national characteristics through animation is a difficult problem. When creating animation, it is necessary to grasp the essence of Chinese traditional culture, and perfectly combine animation with traditional Chinese elements, so as to give animation distinctive artistic characteristics. "Shape-shen" and "image-

image” are two aesthetic concepts of “imagery” and “vitality” in traditional Chinese painting. Using elements that embody traditional Chinese aesthetic thoughts, a very good artistic effect can be achieved in animation design. Literature [1] analyzes the artistic theories of “shape-spirit” and “image-image” in traditional Chinese painting. Traditional Chinese culture is extensive and profound and has a profound impact on animation creation with its rich and profound cultural form. Literature [2] explains that when starting character creation, we must pay attention to the elements to grasp the essence of traditional culture and give animated characters distinct artistic characteristics. Literature [3] explains some problems and solutions in the development of Chinese animation. Literature [4] focuses on Chinese culture through the combined analysis of animation images and Peking opera. Web-based animation includes 2D animation and 3D animation, which introduces cartoon scene design, dangerous behavior, and interaction of characters [5]. Literature [6] mainly analyzes the development status of Chinese traditional story-based animation and proposes new ideas for the development of Chinese animation. Literature [7] demonstrates the detailed process of how to make a two-dimensional animation skit based on flash 8.0 and provides a reference for those who interpret the splendid Chinese traditional culture through animation technology. Literature [8] used engineering thinking in the implementation of two-dimensional animation projects and proposed a process model for the implementation of two-dimensional animation projects. Literature [9] proposed a method of mapping a series of human bone key points in the video to a two-dimensional character to generate a two-dimensional character animation. Literature [10] introduced a fast interpolation technology that can be applied to computer animation, geometric modeling, CAD, and other fields. Literature [11] proposed a two-dimensional animation automatic generation technology. Literature [12] proposed an image-based coloring pipeline to provide a 3D appearance to 2D characters by directly inspecting hand-drawn images. The main purpose of the literature [13] is to explain the proficiency of the parallax engine in processing visual tasks. The main purpose of the literature [13] is to explain the proficiency of the parallax engine in processing visual tasks. Literature [14] elaborated on the fusion art of 2D animation and 3D animation, using 3D technology to express the effect of 2D animation. Literature [15] discusses the application of shape blending in key frame animation.

## 2. 2D Animation Application in Traditional Chinese Elements

*2.1. Traditional Element Animation Scene Detail Control.* The structure diagram of 2D animation application in traditional Chinese elements based on deep learning technology is shown in Figure 1 [16].

As shown in Figure 1, the detailed control of Chinese traditional element animation scenes based on deep learning technology mainly includes three core structures. When the user enters the desired Chinese

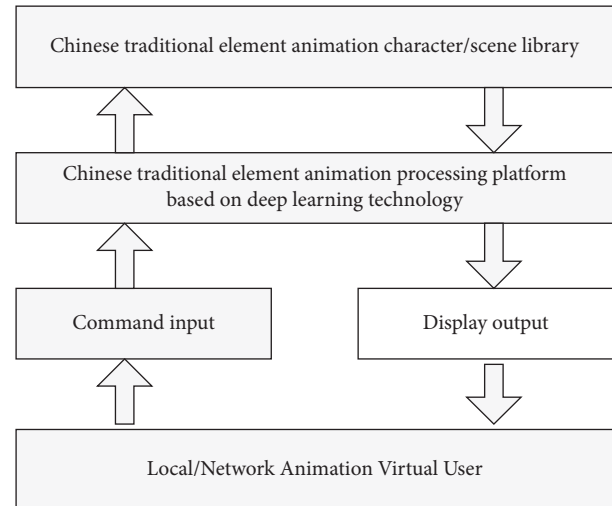


FIGURE 1: Animation control structure diagram.

traditional element animation instructions on the client, the client will automatically enter the instructions into Chinese traditional element animation processing platform. After selecting certain design materials on the platform, deep learning animation smoothing technology can be used to improve the completion of Chinese traditional element animation and then feedback to virtual customers.

*2.2. Construction of Traditional Element Animation Scene Library.* The constructed traditional Chinese element animation scene library is shown in Figure 2. The traditional Chinese element animation scene library mainly includes three views: traditional Chinese element scene view, traditional Chinese element scene structure tree view, and traditional Chinese element code view. These three scenes all have completed the design of Chinese traditional element animation from a different perspective.

The 2D animation scene detail control model using deep learning technology is used to draw the animation elements of the Chinese Spring Festival and Lantern Festival, as shown in Figures 3 and 4.

*2.3. Traditional Element Animation Processing Platform.* The structure of the traditional element animation processing platform based on deep learning is shown in Figure 5 [17]. The structure of the traditional element animation processing platform handles the details of the traditional element animation scenes from the objective and subjective levels. The subjective is mainly the subject experience, which belongs to the aesthetic level; the objective is mainly the object feedback, and the time collage and space reconstruction are completed through digital technology. Reality and fiction need to be integrated. The realization technology of the main and guest levels of the platform is mainly the traditional element animation level detail smoothing technology based on deep learning technology. Through this technology, the

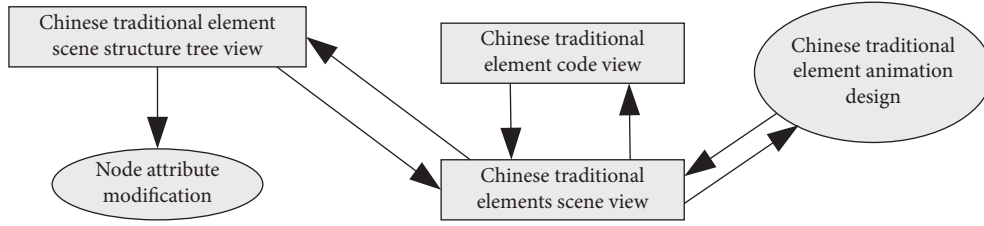


FIGURE 2: Construction of Chinese traditional element animation scene library.



FIGURE 3: Visual symbols of the Spring Festival.



FIGURE 4: Visual symbols of Lantern Festival.

smoothness of the traditional element animation scene details is improved, and the automatic control of the traditional element animation scene details is completed.

### 3. Research on the Application of Chinese Traditional Element Animation Based on Deep Learning

**3.1. Application of Chinese Traditional Element Animation.** The two-dimensional traditional element animation scene uses a uniform difference function and cannot jump to core frame  $k$ . At time  $h$ ,

$$\frac{h}{k} \in [h_j, h_{j+1}] (h_j, h_{j+1} \in [0, 1]). \quad (1)$$

In the traditional element animation scene rendering, when refreshing at  $h$  o'clock  $B_{x,p}$ , the distance between the traditional element animation model  $y$  and the viewpoint  $e$

and the subsequent animation amplitude are dynamically set  $m$ ,  $G_{y,q,h}$ ,  $G(B, h)$  to complete the smoothing of  $B_{x,p}$  dynamic levels.

So,

$$G'_{y,q,h} = \begin{cases} g'_0, & e_M < e_h, \\ g'_1, & e_{M-1} < e_h \leq e_M, \\ \vdots, & \\ g'_{M-1}, & 0 < e_h \leq e_0. \end{cases} \quad (2)$$

Set the distance from the viewpoint to the traditional Chinese element animation model to  $e_h$ , and the initial value of the frequency to  $g'_0$  is

$$G''_{y,q,h} = \begin{cases} g''_0, & \sigma_M < \sigma_h, \\ g''_1, & \sigma_{M-1} < \sigma_h \leq \sigma_M, \\ \vdots, & \\ g''_{M-1}, & 0 < \sigma_h \leq \sigma_0. \end{cases} \quad (3)$$

The amplitude of the traditional element animation is set to  $\sigma$ , and the initial value of the frequency is set to  $g''_0$ .

$$G_{y,q,h} = \sigma_1 G'_{y,q,h} + \sigma_2 G''_{y,q,h}. \quad (4)$$

**3.2. Application of 2D Traditional Element Animation Technology.** For a marked animated image of traditional Chinese elements, use the horizontal and vertical coordinates of each marked feature point to represent the shape vector  $X_i$  [18]:

$$X_i = (X_{i,0}, Y_{i,0}, X_{i,1}, Y_{i,1}, \dots)^T. \quad (5)$$

Characteristic values of traditional elements:

$$\lambda_{\text{total}} = \sum_{i=t}^{2N} \lambda_i. \quad (6)$$

After arranging the eigenvalues of traditional elements in the descending order, select the first  $t$  eigenvalues to satisfy [19]:

$$\sum_{i=t}^t \lambda_t \geq \alpha \lambda_{\text{total}} 0 \leq \alpha, \quad (7)$$

expressed by average shape

$$X = \bar{X} + 1. \quad (8)$$

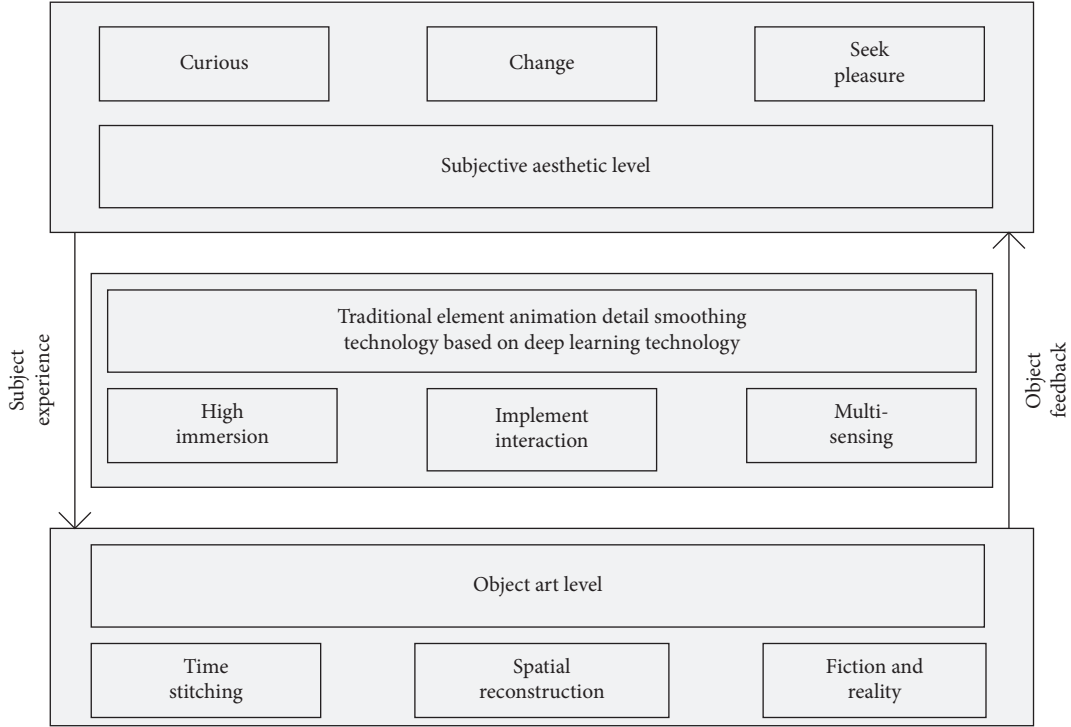


FIGURE 5: Traditional element animation processing platform structure.

Standardization:

$$dg_{ij} \longrightarrow \frac{dg_{ij}}{\sum_{i=1}^{2K+1} |d_{ij}g|}. \quad (9)$$

Calculate the mean:

$$\begin{aligned} \bar{l}_j &= \frac{1}{N} \sum_{i=1}^N dg, \\ j &= \frac{1}{N} \sum_{i=1}^N (dg_{ij} - \bar{l}_j)(dg_{ij} - \bar{l}_j)^T. \end{aligned} \quad (10)$$

Initially, given the traditional element image shape,

$$X' = M(s, \theta)[X] + X_c. \quad (11)$$

The adjustment amount of the current traditional element image coordinate points [20] is

$$\begin{aligned} M(s(1+ds), (\theta+d\theta))[X+dX] + (X_c+dX_c) &= (X+dX), \\ M(s(1+ds), (\theta+d\theta))[X+dX] &= (X+dX) - (X_c+dX_c), \\ M^{-1}(s, \theta)[X] &= M(s^{-1}, -\theta)[X]. \end{aligned} \quad (12)$$

Then [21],

$$\begin{aligned} dX &= M((s(1+ds))^{-1}, -(\theta+d\theta))[Y] - X, \\ Y &= X + dX - (X_c + dX_c). \end{aligned} \quad (13)$$

Convert  $dX$  to the form of model parameter representation [22]:

$$\begin{aligned} X + dX &\approx \bar{X} + P_t(b_t + db_t), \\ X &= \bar{X} + Pb. \end{aligned} \quad (14)$$

Approximate value of shape change [23]:

$$dX \approx P_t(db_t), \quad (15)$$

thereby

$$\begin{aligned} P_t^T &= P_t^{-1}, \\ db_t &= P_t^T dX. \end{aligned} \quad (16)$$

Limit the value of  $b$ :

$$D_m^2 = \sum_{k=1}^t \left( \frac{b_k^2}{\lambda_k} \right) \leq D_{\max}^2, \quad (17)$$

$$b_k \longrightarrow b_k \cdot \left( \frac{D_{\max}}{D_m} \right) (k = 1, 2, \dots, t).$$

After calculating the changes in pose and shape parameters, let [24]

$$\begin{cases} X_c \longrightarrow X_c + w_t dX_c, \\ Y_c \longrightarrow Y_c + w_t d, \\ \theta \longrightarrow \theta + w_\theta d\theta, \\ s \longrightarrow s(1 + w_s ds), \\ b \longrightarrow b + w_b db. \end{cases} \quad (18)$$

After the parameters are updated [25],

$$X' = M(s, \theta)[X] + X_c. \quad (19)$$

## 4. Simulation Experiment

*4.1. Analysis of Simulation Experiment Results.* In order to test the control effect of the 2D animation system based on deep learning, the experiment selected 7 animation scenes of Chinese calligraphy, Chinese knots, Peking opera face-changing, martial arts, shadow puppets, New Year paintings, and terracotta warriors. The 2D animation system proposed in the article was used to analyze these 7 animation scenes. In order to increase the credibility of the experiment, we observe and record the results of the experiment based on the two indicators of roughness of detail and clarity of image quality. Sharpness refers to the sharpness of each detail and its borders on the image. Sharpness, generally from the perspective of the video recorder, compares the image quality by looking at the clarity of the playback image, so the term sharpness is often used. The camera generally uses the term resolving power to measure its ability to “resolve the details of the subject.” The unit has “TV line,” also known as line, 4K resolution, 8K resolution, etc. The higher the definition, the smoother the animation. The detailed roughness comparison chart is shown in Figure 6, and the image quality clarity comparison chart is shown in Figure 7:

According to the data in Figure 6, we can conclude that the 2D animation system proposed in the article has always kept the roughness of detail below 2% in the 7 traditional element animation scenes, which is the lowest roughness of the 3 systems. The detail roughness of the dynamic animation interactive system in the 7 animation scenes is maintained within the range of 11%–21%, and the roughness of the terracotta warriors and horses is the highest, reaching 21%. The detail roughness of the real-time character animation system is the lowest among the three systems and remains within the range of 25%–27%. Among them, the roughness of shadow puppets, New Year paintings, and terracotta warriors all reach 27%.

According to the data in Figure 7, we can conclude that the image quality of the system proposed in the article is higher than 99% in the seven animation scenes, which is the highest of the three systems. The definition of the image quality of the 6 animation scenes of the dynamic animation interactive system is maintained at 91%, the definition of martial arts animation is 96%, and the definition of the image quality of the real-time character animation system is the lowest among the three systems. The interval is 85–88%. According to the experimental data of detail roughness and image quality clarity, it can also be shown that the system proposed in the article has the best control effect for different animation scene details. The experiment also analyzed the dynamic light and shadow of animation scene details of three different systems. Light and shadow play a very important role in animation. Light and shadow design is an indispensable and important link in animation production. It affects the shaping of the character image of the film and the atmosphere and emotional

tone of the entire film, and it has a huge effect on the visual effect of the film. The dynamic light and shadow contrast is shown in Figure 8:

According to the experimental data in Figure 8, we can conclude that the 2D animation system proposed in the article presents a steady trend of fluctuations in the dynamic light and shadow of the 7 traditional element animation scene details, and the detail connection is better. The dynamic animation interaction system and the real-time character animation system have dynamic light and shadow one after another, and the details are poorly connected.

*4.2. Test of the Proportion of Resources.* When the experiment controls the details of the scene animation of traditional Chinese elements, the resource proportions of three different systems are tested, and the test results are shown in the table. According to the test results in Table 1, the system proposed in the article occupies the least memory among the three systems, and the memory occupation and video memory occupation are 488 MB and 980 MB, respectively, indicating that the animation system proposed in the article has the best performance and the highest stability. The difference between memory and video memory is as follows, and the working objects are different: video memory is for temporary storage of data for GPU; while memory is for CPU and system cache data space, if an integrated graphics card is used, that is, the system does not have a separate video memory, the video memory space is divided in the memory space. The storage speed is different: taking GDDR6 memory as an example, the speed can reach up to 72 GB/s; while the speed of DDR4 memory is 25.6 GB/s. Different capacities: the memory capacity is fixed, the capacity configured by the graphics card manufacturer is the upper limit, and consumers cannot add it by themselves; while the memory of consumer-grade computers is based on the DDR slot as the standard, and the memory capacity can be increased or decreased according to the demand and the number of slots on the motherboard. The memory and video memory test results are shown in Table 1.

According to the data in Figure 9, we can conclude that, among the details of different animation scenes, the system proposed in the article has the smallest proportion of memory and video memory. The proportion of video memory is the smallest, and the minimum value is 967. Because the animation of Chinese calligraphy has more details, the proportion of memory and video memory is more than other animations. The proportion of the real-time character animation system is the highest among the three systems. The memory proportion of the Terracotta Warriors reaches 906, the video memory proportion of Chinese calligraphy reaches 1682, and the dynamic animation interactive system accounts for the memory and video memory. In the middle of the two, Chinese calligraphy has the smallest proportion of memory; at least 654, Terracotta Warriors has the largest proportion of memory, the largest is 723, the shadow puppet animation has the smallest proportion of video memory, the smallest is 1601, and Chinese calligraphy has the largest proportion of video memory, the largest is

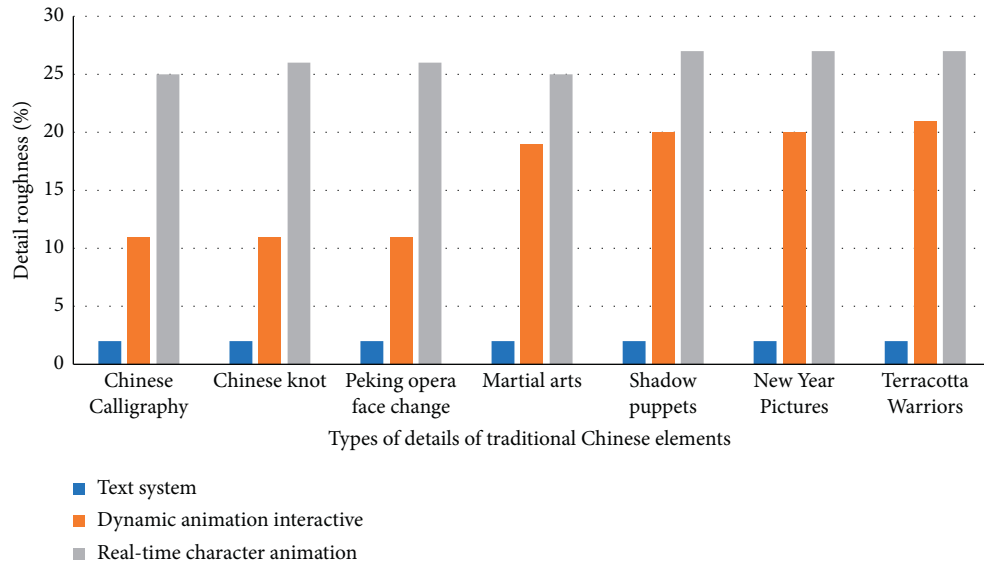


FIGURE 6: Comparison of details and roughness.

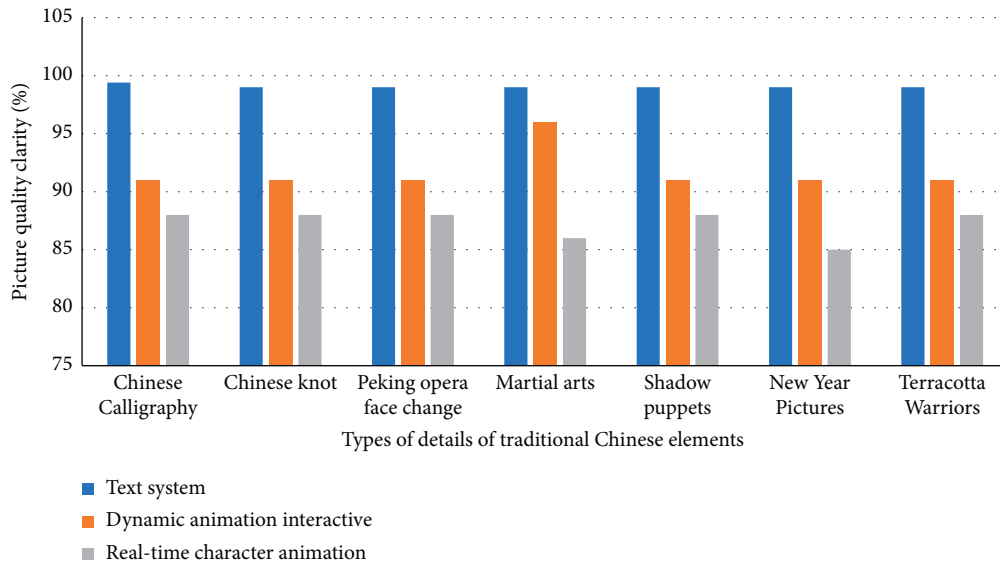


FIGURE 7: Comparison of image quality and clarity.

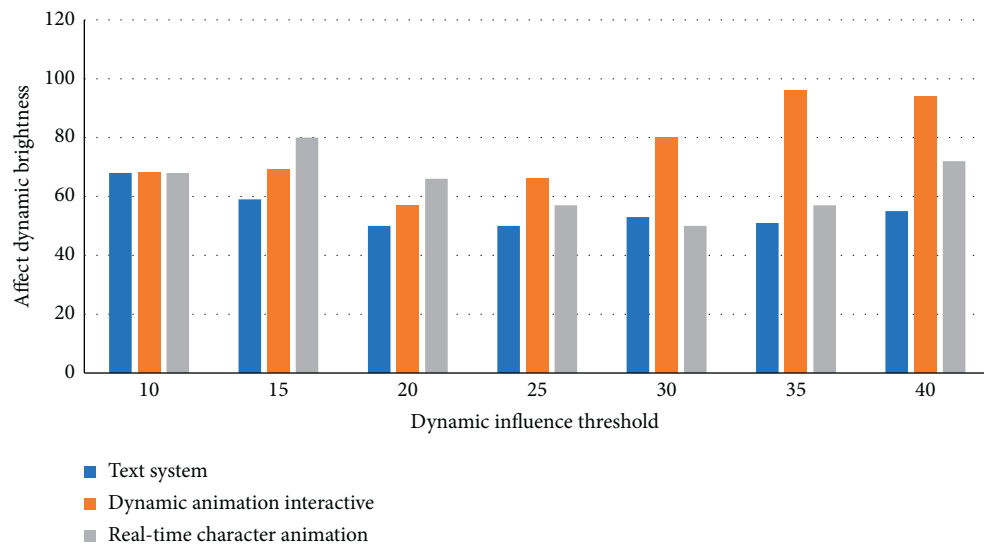


FIGURE 8: Comparison of dynamic light and shadow.

TABLE 1: Memory and video memory test results.

Scene details	Text system		Dynamic animation interactive system		Real-time character animation system	
	RAM	Video memory	RAM	Video memory	RAM	Video memory
Chinese calligraphy	512	1002	654	1723	823	1682
Chinese knot	498	987	687	1236	854	1601
Peking opera face change	488	983	689	1703	876	1682
Martial arts	498	973	699	1682	888	1601
Shadow puppets	478	976	703	1601	896	1682
New Year Pictures	475	967	713	1782	905	1601
Terracotta Warriors	469	969	723	1702	906	1646
Mean	488	980	695	1633	878	1642

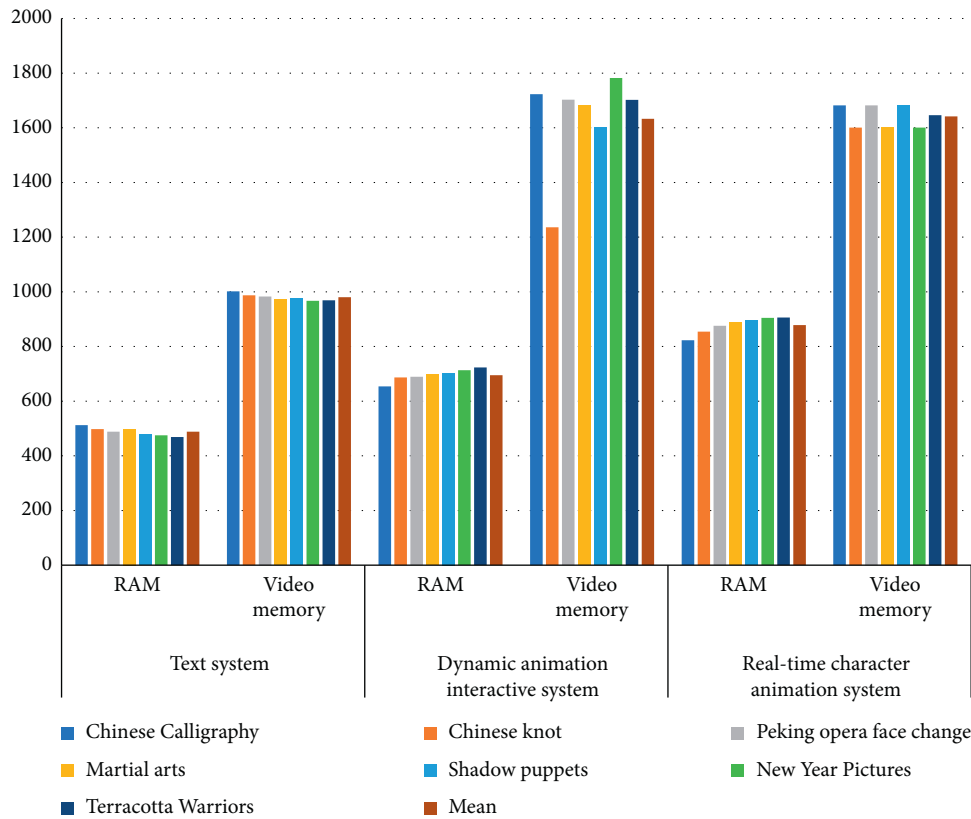


FIGURE 9: Memory ratio diagram.

1723. The experimental results can also show that the system proposed in the article can save a lot of space in the process of animation production.

4.3. *Comparative Experiment.* The Mid-Autumn Festival, also known as the Reunion Festival, is a traditional Chinese festival. During the Mid-Autumn Festival, people will eat moon cakes and admire the moon together. The Mid-Autumn Festival also has a very beautiful mythical story. The experiment chose the one of Chang’e flying to the moon as shown in Figure 10. Animated image: the experiment compares the operation time of the 2D animation system proposed in the article with the dynamic animation interaction system and the real-time character animation system

in the animation drawing process, the number of animation collisions, and the animation distortion rate. The specific experimental data are shown in Table 2:

According to the experimental data in Figure 11, we can conclude that the waiting time of the 2D animation system proposed in the article is the lowest among the three systems. Only in a few cases, it is necessary to wait until 1 s, and there is no delay in the rest of the animation scenes. The waiting time of the dynamic animation interactive system is maintained within 2–4 seconds, and the waiting time for image waiting and image production is 4 seconds. The waiting time of the real-time character animation system is the highest among the three systems, and it is maintained within 2–6 seconds. Among them, the waiting time for image surface copying is 6 seconds. The experimental results





FIGURE 10: Animation template of Chang'e flying to the moon.

TABLE 2: Operation time of each animation.

Experiment content	This paper studies the system waiting time	Dynamic animation interactive system waiting time	Real-time character animation system waiting time
Wait for completion	0	2	3
Image texture swap waiting	0	2	5
Image texture swap out waiting	1	2	4
Image texture processing waiting	0	3	5
Image waiting time	0	4	3
Image surface copy waiting	1	2	6
Image buffer waiting	1	3	4
Image surface preparation waiting	0	4	5

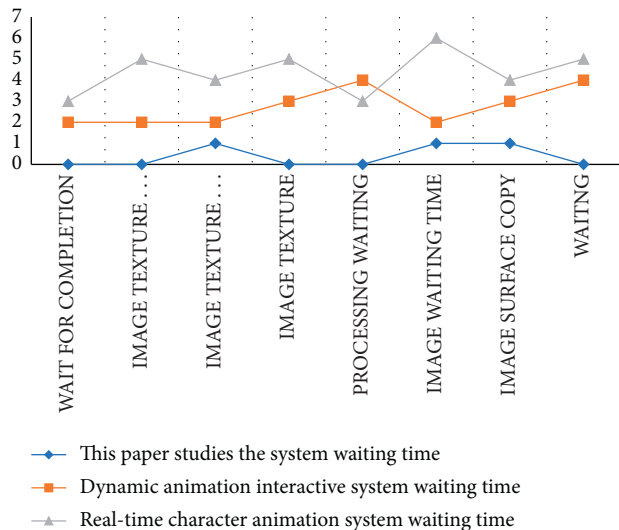


FIGURE 11: Comparison of animation operation time.

show that the real-time operation of the dynamic animation interactive system and the real-time character animation system is poor, and there is a certain delay, while the system proposed in the article has strong real-time operation and shorter operation time. The comparison of the number of animation collisions and the comparison of virtual

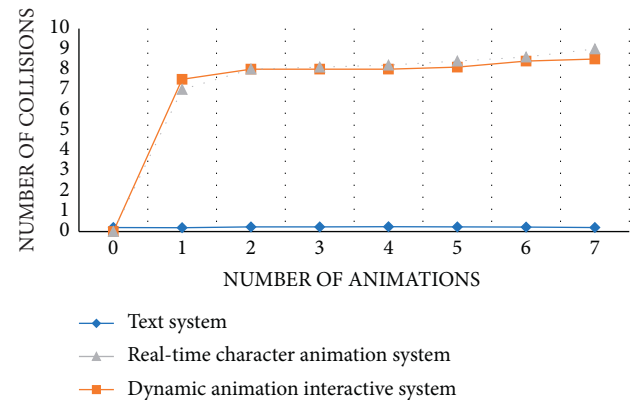


FIGURE 12: Number of animation collisions.

animation distortion rate are shown in Figures 11 and 12, respectively.

According to the experimental data in Figure 12, we can conclude that the 2D animation system proposed in the article has the least number of collisions, almost negligible. Both the dynamic animation interaction system and the real-time character animation system have a certain degree of collision. When the number is 7, the number of collisions of the real-time character animation system reaches 9 times, and the dynamic animation interaction system reaches 8.5 times.



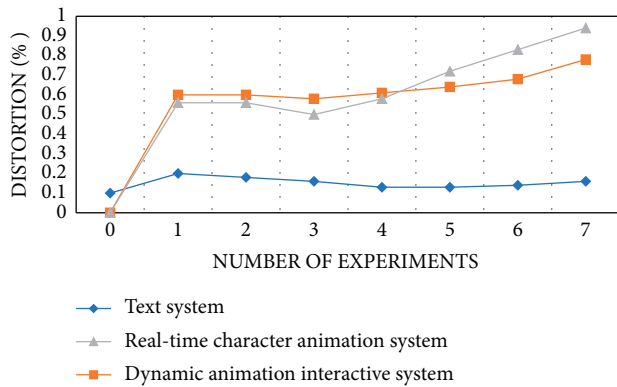


FIGURE 13: Comparison of virtual animation distortion rate.

According to the experimental results in Figure 13, we can conclude that the distortion rate of the 2D animation system proposed in the article is generally low and will not increase with the increase of the number of experiments. The other two systems have higher animation distortion rates and distortion rates. It will increase in varying degrees with the increase of the number of experiments, which cannot meet the needs of animation production.

## 5. Conclusion

To sum up, compared with the other two systems mentioned in the article, the 2D animation system based on deep learning technology studied in the article has less animation operation time and animation collision times, animation distortion rate is relatively low, and the actual application of animation is relatively low. The animation distortion rate is relatively strong, which can meet the needs of virtual animation production. Through the description of the article, in the study of the detailed control of different animation scenes of traditional Chinese elements, the roughness of the image quality can be effectively reduced, and the clarity of the image quality can be improved, which solves the problems of long production time and more collisions in traditional animation and greatly improve the application value. However, due to time constraints, the system proposed in the article still has some shortcomings and does not control the cost of animation production. In the subsequent research process, we must focus on how to improve the application performance of the animation system and provide technology for 2D animation production. support. Whether from a historical perspective or a modern perspective, there is a huge potential for the development of Chinese traditional festival element animation. In addition, since the development of domestic animation, although the traditional festival culture has a long history and rich festival elements, the number of animation works that can apply Chinese traditional festival elements is relatively small. In fact, in animation design, what we lack is never the material and content, but the lack of a kind of responsibility and belief in the inheritance of traditional festival culture. Through the research of this topic, it can be seen that the collision of

traditional festival culture and modern animation design concepts can make traditional Chinese festivals show new vitality and inherit traditional festival culture.

## Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

## Conflicts of Interest

The authors declare that they have no conflicts of interest regarding this work.

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