



Research on the Application of Virtual Reality Technology in Digital Media Art Teaching

Ying Shi^{1*}  and Yan Liu² 

¹Department of Film and Television Art, Shanghai Publishing and Printing College, Shanghai, 200093, China

YanLiu20230908@outlook.com

²School of Journalism and Communication, Shanghai Jianqiao University, Shanghai, 201306, China

Corresponding author: Ying Shi, lulustone@163.com

Abstract. Digital art design is a discipline formed under the conditions of the high integration of art and technology, natural science, and art science. According to its characteristics, digital art design education can be divided into two levels: computer graphics technology education and art education. According to the principle of the camera's pinhole imaging model and the collinear equation, this paper adopts the method of direct linear transformation to calibrate the camera according to 6 control points, and obtain the camera parameters needed in augmented reality. At the same time, this paper uses the calibration results to measure flat objects and verifies the effectiveness of the method through measurement errors. In addition, this paper combines virtual reality technology to construct a digital media art teaching system. After constructing the system model, this paper verifies the performance of the model and counts the results of the experimental research. From the experimental research, we can see that the system model proposed in this paper has a good teaching effect.

Keywords: Virtual reality; digital media art; intelligent model; machine learning

DOI: <https://doi.org/10.14733/cadaps.2024.S17.171-186>

1 INTRODUCTION

The development of society and the progress of science and technology are the basis for the birth of different art forms. Therefore, as computers continue to enter thousands of families, it marks the arrival of the digital age, and thus, the art form of new media art was born. In the beginning, most of the new media majors in our country were vocational colleges and training institutions. Moreover, China's new media art started relatively late and began to develop gradually in 1990 [19]. At the end of the twentieth century, the widespread use of computers created conditions for the rapid

development of new media art, and it has been connected to all walks of life. For example, online games, 3D movies, and various web pages that are browsed every day are inseparable from new media technologies, and new media art is needed to design them. Due to the rapid development of new media art in society, the society has a great demand for professional talents. At the same time, new media art education must also conform to the trend of the times and become the most promising new favorite among colleges and universities, and has received strong support from the government. As early as 2004, the Ministry of Education of my country added the major of digital media art to the professional catalog. The main task of colleges and universities at this stage is to cultivate new media art talents who have both artistic accomplishment and understanding of art, as well as scientific and technological strength and knowledge of technology [4].

With the emergence and development of new media technology, the specialty of new media art was born. New media technology can achieve faster transmission of larger-capacity information and quicker responses. Moreover, it is characterized by fast speed, quick way and large capacity. For example, people communicating on the Internet is also a very fast way of communication, so in comparison, traditional art does not have the communicative nature of new media art. However, relying on the new media art computer hardware interface and software technology, we can quickly realize the interactive function, so that we can achieve a better combination of the operator and the computer, and achieve the effect of man-machine integration. Therefore, we can continue to innovate and transform. At the same time, art appreciators can also communicate and interact. In addition, new media art enables more art lovers to understand art deeply, improve aesthetic vision and stimulate innovative thinking [2].

Since new media is an industry that our country is now vigorously developing, many schools have also successively launched new media majors. However, since the birth of new media art, many institutions have not had a clear goal in their disciplinary status, and they are not even clear about what is new media art and what is new media technology. The Communication University of China has made a targeted segmentation of new media art and new media technology in terms of teaching goals, which has made a major breakthrough in the distinction of China's majors. From this point of view, new media art should also have a professional direction.

Digital art is an art created with digital methods and concepts. How to integrate existing online teaching resources to build a digital art learning platform in a new environment will directly affect the teaching quality of digital art courses centered on digital content innovation. At the same time, with the rise of digital art craze, the society has an urgent demand for digital talents, and cultivating high-quality digital talents has become an issue of great concern to the society. Therefore, in order to meet the requirements of society, it is necessary to explore a digital art teaching and digital art talent training model to better serve the innovative education of digital art courses in colleges and universities and to train qualified digital art designers.

This article uses virtual reality technology as the basic technology to construct a digital media art teaching system based on virtual reality technology.

2 RELATED WORK

Digital art generally refers to various forms of artistic works with independent aesthetic value produced through digital and information technology, and it advocates the intersection of digital science and design art [15]. For example, computer-aided industrial design, CAD/CAM, digital and music, FLASH, online games, movie special effects, and computer animation, which are increasingly deepening into public life, all belong to the category of digital art [7]. As an educational research direction that has emerged in the field of art design education with the popularization of digitalization, digital art design education aims to cultivate professional talents who use digital media elements such as images, sounds, digital graphics and images to carry out art design [22]. It enables

students to combine the new concept of art design with digital technology, use digital media technology and integrate multiple media expressions to conduct digital media art design exploration research [9]. It is necessary to train students to have a solid theoretical foundation of digital media art design discipline and good academic literacy, so as to adapt to the demand for art design talents in the digital information society. Its particularity, complexity and interdisciplinary characteristics have brought new challenges to normal teaching management, especially new challenges and requirements for the traditional school-running model [21]. For this emerging field of education, art and design education practitioners all over the world are full of passion and expectation, and have devoted themselves to the theoretical research of digital art design education. At present, foreign countries are in a leading position in the design and development of teaching management software, and they are very successful in both the development method and the utilization rate of the software. Especially developed countries in Europe have achieved very good results in digital art and design education. Moreover, they regard digital art design as the focus of art design professional education, set up new disciplines such as game design, digital communication and digital image special effects, and cultivated a group of high-quality comprehensive digital art design professionals [6].

The literature [5] introduced the realization of registration technology in augmented reality system. The literature [14] focused on how to classify and track targets in real-time video. The literature [18] implemented a preliminary augmented reality system in the laboratory to train students to learn the internal structure of the computer. Through the video see-through helmet, the system can add the description information of each part of the computer to the video. The literature [3] proposes a multi-source data integration method based on the combination of virtual and real, which combines sighting reports, aerial and satellite pictures, sonar, radar, earthquake, infrared and other information into an environment where virtual objects and real environments coexist. The literature [1] used a handheld augmented reality method (Hand held display, HHD) to design a magic book, which integrates virtual objects and real books. The literature [11] proposed a graph of the relationship between virtual environment and real environment. The augmented reality system researched and developed by the literature [20] is mainly used in a collaborative work environment based on medical data visualization and an enhanced virtual creation environment for entertainment. The literature [17] adopted the method of image recognition and marking to realize the fusion of virtual and actual, and it was quite effective to study and treat some human cockroach phobias. The SekaiCamera application software developed by Japanese mobile application manufacturer Tonchidot obtains the latitude, longitude and altitude through GPS, uses the geomagnetic sensor (electronic compass) to obtain the facing direction, and obtains the tilt angle through the acceleration Sensor, and then obtains the relevant information according to the position information and superimposes the display, so that the user can obtain the information while watching the factual image of the surrounding environment through the mobile phone [8]. The system developed in the literature [16] captures the feature points from the photographic image, then detects the plane, establishes virtual 3D coordinates on the detected plane, and then synthesizes the photographic image.

3 CAMERA IMAGING PARAMETERS

The camera imaging parameters are also the photo parameters. The photo parameters are the basic elements to establish the mathematical model between the pixel points and the spatial features. According to the principle of photogrammetry, the image parameters include the following:

1. Photography location information

That is, it refers to the spatial position of the center s of the camera's objective lens at the moment when the photo is taken, represented by X_s, Y_s, Z_s , which is also called the linear element of the orientation element outside the photo.

2. Photography posture information

The orientation line of the main optical axis of the camera is called the photographic orientation line at the moment of photography. The spatial posture of the photographic orientation line is generally determined by the rotation angle of the photographic orientation line in the photogrammetric coordinate system. In close-range photogrammetry, the spatial attitude angle is often represented by an $\varphi - \omega - \kappa$ system. Among them, φ represents the deviation angle of the photographic direction line in the horizontal direction, called the roll angle; ω represents the deviation angle of the photographic direction line in the vertical direction, called the pitch angle; κ represents the rotation angle of the close-range image itself around the principal optical axis of the photography, called the rotation angle. φ, ω, κ is also known as the angular element of the out-of-picture orientation element. X_s, Y_s, Z_s and φ, ω, κ are collectively referred to as the exterior orientation elements of the photograph.

3. Internal orientation elements of the photograph

The interior orientation element of a photograph contains three basic elements, f, x_0, y_0 . f denotes the focal length of the camera objective, and x_0, y_0 denotes the deviation of the intersection O of the camera's main optical axis and the photograph plane from the image center. The three interior orientations f, x_0, y_0 of a digital photograph are all represented in pixels [10].

4. Distortion coefficient of photograph

Photo distortion is the main factor that affects the accuracy of image measurement by non-photogrammetric cameras. Traditional objective distortion mainly refers to the point error caused by the deviation of the image point from its ideal position caused by the design, fabrication and assembly of the objective system. For digital cameras or digital cameras, there will also be electronic distortion independent of the objective. In order to fully describe the distortion of digital photographs, the concept of image distortion is used to summarize the objective and electronic distortion contained in digital photographs. In this paper, the model shown in the following formula is used to solve the problem.

$$\begin{cases} \Delta x = (x - x_0)(k_1 r^2 + k_2 r^4 + k_3 r^6) + p_1 [r^2 + 2(x - x_0)^2] \\ \quad + p_2 [r^2 + 2(x - x_0)(y - y_0)] \\ \Delta y = (y - y_0)(k_1 r^2 + k_2 r^4 + k_3 r^6) + p_1 [r^2 + 2(y - y_0)^2] \\ \quad + p_2 [r^2 + 2(x - x_0)(y - y_0)] \end{cases} \quad (1)$$

This mathematical model accurately calculates the distortion coefficient k_1, k_2, k_3, p_1, p_2 by establishing a calibration site. In this paper, the simplified distortion model of the modified model is used:

$$\begin{cases} \Delta x = k_1 (x - x_0) r^2 \\ \Delta y = k_1 (y - y_0) r^2 \end{cases} \quad (2)$$

Four coordinate systems are used in the process of studying the principle of camera imaging: image pixel coordinate system, ideal screen (imaging plane) coordinate system, camera coordinate system and marker (world) coordinate system, as shown in Figure 1.

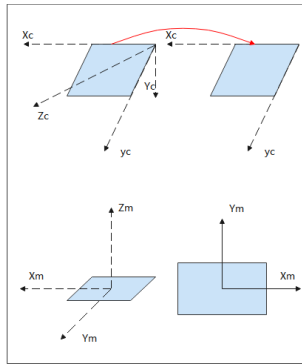


Figure 1: Four reference coordinates.

1. Image pixel coordinate system (x_d, y_d)

As shown in the red coordinate system in Figure 1, the image coordinates are divided into two types. One is physical coordinates, which are measured in length units. The other is pixel coordinates, which are measured by the number of pixels. The image pixel coordinate system here refers to the pixel coordinates of the image coordinates, that is, the coordinates of the image on the plane where the image was taken. The conversion relationship between these two coordinates can be seen in Figure 2.

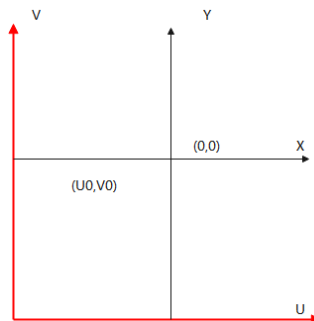


Figure 2: Conversion relationship between physical coordinates and image coordinates.

Point 0 in the figure is the intersection of the plane of the coordinate system and the optical axis of the camera. As shown in Figure 2, this point is also the origin of the physical coordinate system $x - y$. In the pixel coordinate system, the 0 point corresponds to the center point (u_0, v_0) of the image, and d_x, d_y is the length and width of the area of each pixel. Therefore, the following conversion relationship exists between these two coordinate systems[13]:

$$\begin{cases} u = \frac{x}{d_x + u_0} \\ v = \frac{y}{d_y + v_0} \end{cases} \quad (3)$$

2. Ideal screen coordinate system (x_c, y_c)

As shown in Figure 1, the ideal screen coordinates refer to the coordinates projected onto the ideal imaging screen directly using the camera's pinhole imaging model principle.

3. Camera coordinate system

As shown in Figure 1, the optical center of the camera lens is the origin of the coordinate system in the camera coordinate system in the figure, and the z_c axis coincides with the optical axis and is perpendicular to the imaging plane

4. Marker (world) coordinate system

As shown in Figure 1, the origin of the world coordinate system can be arbitrarily specified by the user. As long as the three axes are perpendicular to each other and meet the right-hand rule, they can be rotated at will without any other restrictions. It is mainly used to describe the positions of cameras and objects, and it is a user-defined three-dimensional spatial reference coordinate system. The world coordinate system in this paper is equivalent to a marker coordinate system.

Because the parameters used by ordinary cameras to build the imaging model, such as the camera's imaging principal distance, image principal point, camera lens aberration correction factor, the position and posture at which the image was taken are unknown, strict calibration must be carried out before measuring to obtain the camera's imaging parameters[23].

The imaging model of the camera is shown in Figure 3, where f is the focal length, u is the object distance, O is the optical center, and the image at A is an inverted image. Since the images at A and B are equal upside-down, they can be equivalent to the virtual image plane formed at the focal length on the other side of the optical center during the study. This is also the reason why the ideal screen coordinate system in Figure 2 is between the marker coordinate system and the camera coordinate system.

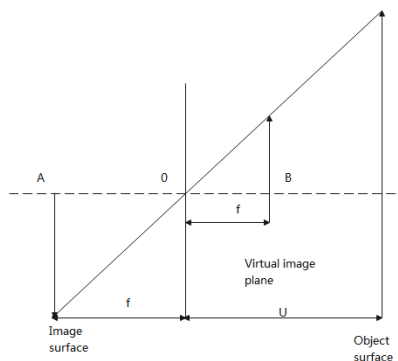


Figure 3: Pinhole imaging model of the camera.

The method of direct linear transformation is to establish a direct linear relationship algorithm between the coordinates of the image point coordinate machine and the space coordinates of the corresponding object point. Because there is no need for the initial approximation of the inner element value and the outer element value, it is especially suitable for photogrammetric processing of images taken by non-measuring cameras. According to the direct linear relationship between the coordinate machine coordinates and the corresponding object coordinates, when the direct linear transformation method is used to solve the problem, we can get:

$$(x - x_0 + \Delta x) = -f \frac{a_1(X - X_s) + b_1(Y - Y_s) + c_1(Z - Z_s)}{a_3(X - X_s) + b_3(Y - Y_s) + c_3(Z - Z_s)} \quad (4)$$

$$(y - y_0 + \Delta y) = -f \frac{a_2(X - X_s) + b_2(Y - Y_s) + c_2(Z - Z_s)}{a_3(X - X_s) + b_3(Y - Y_s) + c_3(Z - Z_s)} \quad (5)$$

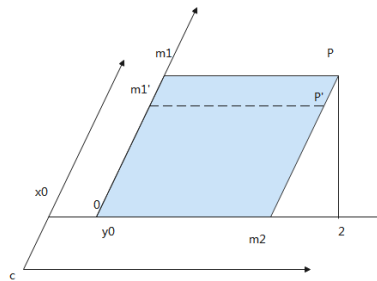


Figure 4: Schematic diagram of the derivation of the direct linear transformation formula.

As shown in Figure 4, in the above formula, the system error correction number n only includes the linear error correction number part caused by the coordinate axis non-vertical error d and the scale error ds . In this model, only the lens distortion correction coefficient of the camera is considered. There are two coordinate systems with the principal point O as the origin, which are the rectangular coordinate system $o - \bar{x}\bar{y}$ and the non-rectangular coordinate system $O-xy$. The coordinate of the principal point O is (x_0, y_0) . The coordinate of a certain image point p' is (x, y) , and the coordinate of point p' in the non-rectangular coordinate system $O-xy$ is (om_2, om_1') . Point p is the ideal position of point p' , and its coordinate (\bar{x}, \bar{y}) in the rectangular coordinate system $o - \bar{x}\bar{y}$ contains no error, where $\bar{x} = on_2, \bar{y} = on_1$. Rows is the total number of rows of the image, $x, Y,$ and Z are the spatial coordinates of the scene point, and X_s, Y_s, Z_s is the spatial position of the center S

of the camera's objective lens at the moment the photo is taken. $\begin{bmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{bmatrix}$ is the rotation matrix determined by the three attitude angles of the camera space attitude according to a certain turning angle system. All system error corrections are summarized in the lens distortion correction number, according to:

$$\begin{aligned} \Delta x &= k_1(x - x_0)r^2 \\ \Delta y &= k_1(y - y_0)r^2 \end{aligned} \tag{6}$$

There are many methods for camera calibration. According to different shooting methods, it is mainly divided into traditional camera calibration method, active vision camera calibration method, and camera self-calibration method. The self-calibration algorithm mainly uses the constraint of camera motion, and the constraint condition of camera motion is too strong, so it is not practical in practice. The camera calibration method based on active vision refers to the calibration of the camera according to some movement information of the camera. This method does not require a calibration object as a reference, but it needs to control the camera to make some special movements. Through the analysis of the particularity of this movement Process to calculate the internal parameters of the camera. The traditional camera calibration method needs to use a calibration object with a known size. By establishing the correspondence between a point with a known coordinate on the calibration object and an image point, a certain algorithm is used to obtain the internal and external parameters of the camera model. The different camera calibration methods according to the solution method can be divided into stepwise method, direct nonlinear solution method and linear solution method. The stepwise method is to solve the lens distortion coefficient separately from other camera parameters, use the linear method to solve some of the parameters as the initial value of the nonlinear method, and then solve the camera parameters through nonlinear optimization. The direct nonlinear solution method first establishes the projection relationship between the three-dimensional coordinates of the calibration point on the calibration reference and the image coordinates, and then uses an iterative algorithm to solve the nonlinear equations. The linear solution method is to combine

the variables of the nonlinear equation into relay parameters, and after the least square method is used to solve the problem, the value of the original variable is obtained. In this paper, according to the traditional camera calibration method, the accurate calibration of the three-dimensional calibration test field is used, and the method of direct linear transformation is used to calibrate the camera with high precision. This method does not need to know the motion parameters, only needs to take a picture of the calibration object, and the shooting position of the camera can be changed at will, which is very convenient and simple to operate.

The stereo digital camera system is calibrated strictly according to the given model. By solving the nonlinear equations, a total of 11 internal and external orientation elements $L = (X_s, Y_s, Z_s, \varphi, \omega, \kappa, x_0, y_0, f_0, d_s, d_\beta)$ are obtained,, which are expressed in matrix form as[12]:

$$L = [l_1 l_2 l_3 l_4 l_5 l_6 l_7 l_8 l_9 l_{10} l_{11}] \quad (7)$$

After successfully taking the photos with measuring frame, we need to use software to process the pictures. Software recovery needs two pictures taken from different angles. First, it is necessary to obtain the image coordinates $(X_1, Y_1, Z_1), \dots, (X_6, Y_6, Z_6)$ and real coordinates $(x_1, y_1), \dots, (x_6, y_6)$ of the 6 identical control points in the two pictures. By solving them simultaneously, we can get:

$$\begin{bmatrix} X_1 & Y_1 & Z_1 & 1 & 0 & 0 & 0 & 0 & x_1 X_1 & x_1 Y_1 & x_1 Z_1 \\ 0 & 0 & 0 & 0 & X_1 & Y_1 & X_1 & 1 & y_1 X_1 & y_1 Y_1 & y_1 Z_1 \\ X_2 & Y_2 & Z_2 & 1 & 0 & 0 & 0 & 0 & x_2 X_2 & x_2 Y_2 & x_2 Z_2 \\ 0 & 0 & 0 & 0 & X_2 & Y_2 & Z_2 & 1 & y_2 X_2 & y_2 Y_2 & y_2 Z_2 \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ X_6 & Y_6 & Z_6 & 1 & 0 & 0 & 0 & 0 & x_6 X_6 & x_6 Y_6 & x_6 Z_6 \end{bmatrix} + \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \\ I_5 \\ I_6 \\ I_7 \\ I_8 \\ I_9 \\ I_{10} \\ I_{11} \end{bmatrix} + \begin{bmatrix} x_1 \\ y_1 \\ x_2 \\ y_2 \\ \dots \\ x_6 \end{bmatrix} = 0 \quad (8)$$

The approximate value of L can be solved according to the above formula. When there are redundant observations, and when the correction number of the image point coordinate observation value is (v_x, v_y) , and the non-linear correction of the image point coordinate is $(\Delta x, \Delta y)$, the following results are obtained according to the basic relationship of the direct linear transformation solution:

$$\left. \begin{aligned} (x + \Delta_x) + \Delta x + \frac{I_1 X + I_2 Y + I_3 Z + I_4}{I_9 X + I_{10} Y + I_{11} Z + 1} &= 0 \\ (y + \Delta_y) + \Delta y + \frac{I_5 X + I_6 Y + I_7 Z + I_8}{I_9 X + I_{10} Y + I_{11} Z + 1} &= 0 \end{aligned} \right\} \quad (9)$$

In the above formula, the non-linear correction of the image point coordinates (mainly the correction of optical distortion) can be substituted into the following formula or a part of it, and take the sign:

$$A = I_9 X + I_{10} Y + I_{11} Z + 1 \quad (10)$$

When only solving k_1 , it is written as:

$$\left. \begin{aligned} A(x + \Delta_x) + A k_1 (x - x_0) r^2 + I_1 X + I_2 Y + I_3 Z + I_4 &= 0 \\ A(y + \Delta_y) + A k_1 (y - y_0) r^2 + I_5 X + I_6 Y + I_7 Z + I_8 &= 0 \end{aligned} \right\} \quad (11)$$

Therefore, the error equation of the observed value of the image point coordinate is:

$$\left. \begin{aligned} v_x &= -\frac{1}{A}[I_1X + I_2Y + I_3Z + I_4 + xXI_9 + xYI_{10} + xZI_{11} + Ak_1(x - x_0)r^2 + x] \\ v_y &= -\frac{1}{A}[I_5X + I_6Y + I_7Z + I_8 + yXI_9 + yYI_{10} + yZI_{11} + Ak_1(y - y_0)r^2 + y] \end{aligned} \right\} \quad (12)$$

The matrix of this error equation and the corresponding normal equation is taken as:

$$\left. \begin{aligned} V &= ML - W \\ L &= (M^T M)^{-1} M^T W \end{aligned} \right\} \quad (13)$$

Among them,

$$M = - \begin{bmatrix} \frac{x}{A} & \frac{y}{A} & \frac{z}{A} & \frac{1}{A} & 0 & 0 & 0 & 0 & \frac{xx}{A} & \frac{xy}{A} & \frac{xz}{A} & (x - x_0)r^2 \\ 0 & 0 & 0 & 0 & \frac{x}{A} & \frac{y}{A} & \frac{z}{A} & \frac{1}{A} & \frac{yx}{A} & \frac{yy}{A} & \frac{yz}{A} & (y - y_0)r^2 \end{bmatrix} \quad (14)$$

$$L = (l_1 l_2 l_3 l_4 l_5 l_6 l_7 l_8 l_9 l_{10} l_{11} k_1)^T \quad (15)$$

$$W = \left[-\frac{x}{A}, -\frac{y}{A} \right]^T \quad (16)$$

$$V = [v_x, v_y]^T \quad (17)$$

4 DIGITAL MEDIA ART TEACHING SYSTEM BASED ON VIRTUAL REALITY TECHNOLOGY

The overall design of the digital media art teaching system based on virtual reality technology is divided into player module, editor module, background management system module, data and file storage module, as shown in the system block diagram of Figure 5. The player module mainly loads materials from the database, reads the script, and then controls the playback of the entire animation. The main function of the editor module is to enable users to edit animation according to their needs, including visual material editing module, text material (subtitle) editing module, audio material editing module, etc., as well as the playback and preview of the edited animation. The background management system module is mainly divided into user management, user authority management, function management, menu management, and animation management. According to the user's authority, operations such as adding, deleting, modifying, and querying can be performed accordingly. The database and file storage module are mainly used for the storage of editing animation action fragments, playback control scripts, and various materials.

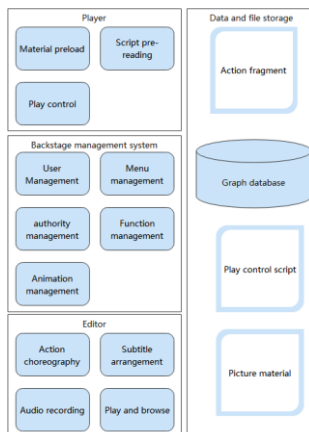


Figure 5: Digital media art teaching system based on virtual reality technology.

The animation player module makes it easier and more convenient for users to play their own customized animations. The function of the player is to pre-load all kinds of materials, so that the animation can be played smoothly and does not need to spend a long waiting time. In addition, the playback process can be controlled according to the specific needs of the user, and it can be played or paused in segments and time-sharing as needed. The working flowchart of the player is shown in Figure 6.

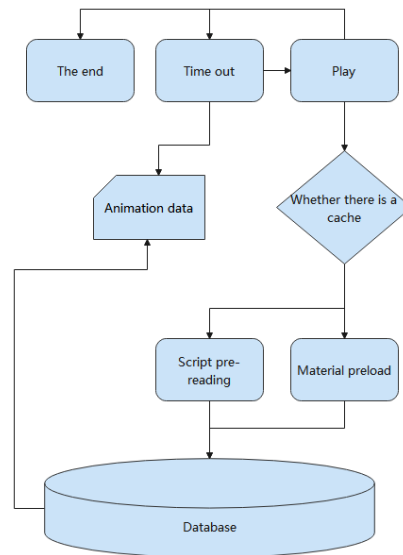


Figure 6: The working flow chart of the player.

First of all, the imported video, 3d, image and other visual materials are dragged to the timeline editor on demand, loaded, edited and adjusted, and a series of materials are combined to form the animation effect we need. In the editing process, operations such as moving, adding, and deleting can be implemented to meet the different needs of various users for material customization, as shown in Figure 7.

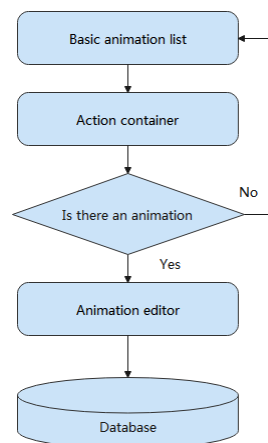


Figure 7: Flow chart of the visual material editing module.

Users can add text (namely, subtitles) to a specific frame of a certain material segment in the timeline according to their own narrative needs to make the expression clearer and clearer, as shown in Figure 8.

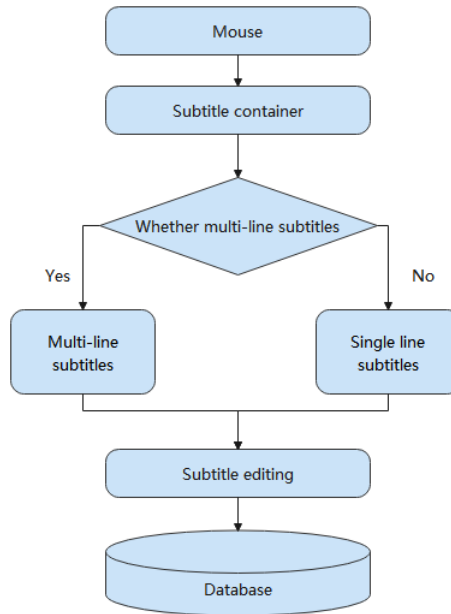


Figure 8: Flow chart of text material editing.

In order to allow users to add sound material to the video according to actual needs, the system provides a real-time recording function and audio material addition function to further improve the author's content in all directions, as shown in Figure 9.

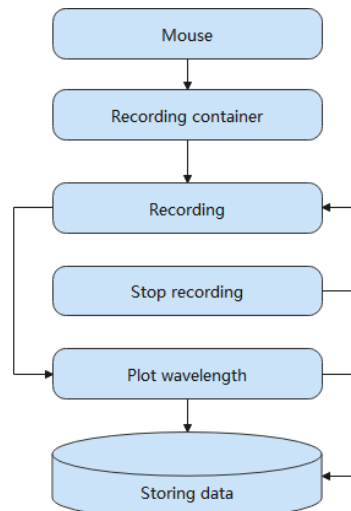


Figure 9: Flow chart of audio material editing.

5 PERFORMANCE VERIFICATION OF DIGITAL MEDIA ART TEACHING SYSTEM BASED ON VIRTUAL REALITY TECHNOLOGY

This article combines virtual reality technology to construct a digital media art teaching system. After constructing the system model, the performance of the model is verified. The experiment designed in this paper is mainly carried out from two aspects: the virtual modeling of the teaching system and the teaching effect. First of all, this paper verifies the effect of virtual modeling and evaluates it through multiple sets of virtual simulations. The results are shown in Table 1 and Figure 10.

<i>Num</i>	<i>Virtual model</i>	<i>Num</i>	<i>Virtual model</i>	<i>Num</i>	<i>Virtual model</i>
1	90.40	28	92.27	55	89.15
2	86.32	29	92.61	56	85.71
3	91.71	30	88.31	57	91.40
4	86.42	31	85.47	58	88.83
5	91.28	32	93.05	59	88.70
6	90.91	33	86.17	60	93.36
7	93.34	34	91.72	61	87.40
8	90.06	35	91.34	62	88.52
9	90.04	36	85.14	63	88.62
10	93.41	37	89.44	64	89.23
11	85.89	38	87.68	65	90.30
12	89.81	39	87.20	66	87.86
13	93.64	40	89.57	67	89.86
14	88.39	41	86.59	68	89.61
15	85.72	42	89.23	69	86.65
16	87.81	43	92.84	70	86.97
17	93.32	44	88.93	71	93.57
18	93.19	45	88.90	72	86.05
19	89.37	46	85.46	73	86.60
20	93.07	47	90.40	74	92.61
21	91.70	48	89.90	75	87.38
22	89.16	49	92.69	76	88.29
23	91.95	50	90.07	77	93.22
24	92.68	51	86.43	78	87.20
25	85.36	52	85.35	79	88.87
26	92.11	53	88.27	80	90.04
27	86.00	54	90.62	81	90.46

Table 1: Statistical table of evaluation of virtual simulation effect.

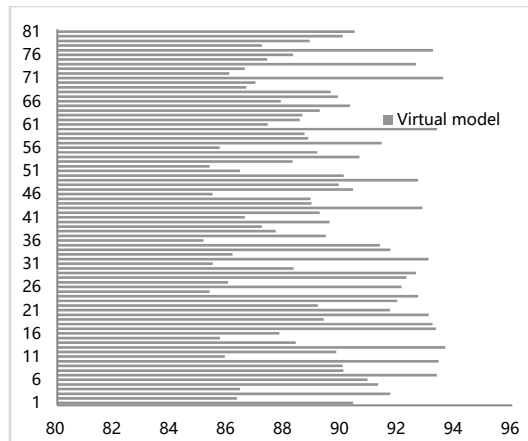


Figure 10: Statistical diagram of evaluation of virtual simulation effect.

On the basis of the above analysis, the system teaching effect evaluation is carried out, and the results obtained are shown in Table 2 and Figure 11.

<i>Num</i>	<i>Teaching effect</i>	<i>Num</i>	<i>Teaching effect</i>	<i>Num</i>	<i>Teaching effect</i>
1	85.81	28	84.38	55	70.05
2	81.23	29	86.42	56	83.06
3	83.18	30	69.61	57	79.66
4	82.12	31	71.64	58	86.48
5	77.38	32	70.28	59	82.55
6	75.81	33	73.95	60	82.60
7	70.00	34	75.94	61	83.38
8	87.08	35	72.83	62	74.34
9	84.16	36	71.79	63	70.93
10	82.78	37	69.07	64	86.64
11	74.88	38	87.92	65	71.81
12	87.21	39	69.60	66	79.58
13	85.31	40	83.99	67	71.62
14	73.68	41	78.61	68	72.83
15	71.00	42	85.59	69	71.33
16	72.50	43	75.32	70	70.67
17	79.63	44	82.24	71	70.55
18	72.25	45	87.81	72	86.03
19	85.67	46	86.41	73	81.92
20	84.90	47	72.95	74	74.53
21	75.84	48	69.79	75	86.20
22	78.06	49	75.49	76	75.55
23	79.87	50	85.90	77	72.22

24	71.50	51	87.45	78	87.54
25	71.96	52	84.23	79	80.42
26	85.88	53	87.67	80	77.85
27	69.96	54	71.61	81	72.36

Table 2: Statistical table of evaluation of teaching effect.

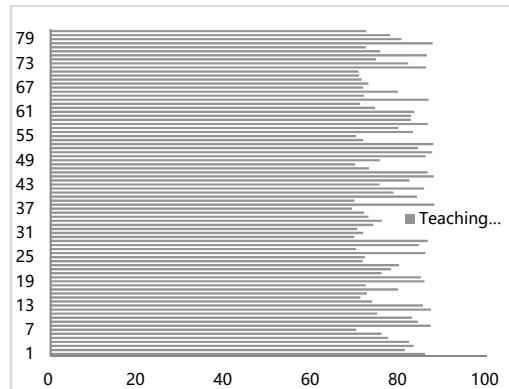


Figure 11: Statistical diagram of evaluation of teaching effect.

From the above experimental research, it can be known that the digital media art teaching system based on virtual reality technology has a reliable teaching effect.

6 CONCLUSION

China's creative cultural industry is entering a new stage of development. This requires domestic art design education to strengthen the in-depth exploration of digital art design education with the strategic goal of "talent training and industry interaction". At the same time, it requires to cultivate design talents who master the digital art knowledge system and design skills, possess scientific spirit and humanistic qualities, and can participate in international competition. This article implements the above concepts to design and develop a digital art teaching information management system. The purpose is to explore a digital media art teaching system based on virtual reality technology. Moreover, this paper analyzes the algorithm of virtual reality technology and constructs a digital media art teaching system combined with virtual reality technology. After constructing the system model, this paper verifies the performance of the model and counts the results of the experimental research. From the experimental research, we can see that the system model proposed in this paper has a good teaching effect.

Ying Shi, <https://orcid.org/0009-0007-4828-4224>

Yan Liu, <https://orcid.org/0009-0005-1493-0844>

REFERENCE

- [1] Alhalabi, W.: Virtual Reality Systems Enhance Students' Achievements in Engineering Education, Behaviour and Information Technology, 35(11), 2016, 919-925. <https://doi.org/10.1080/0144929X.2016.1212931>

- [2] Anand, M.: et.al. Multiple Metric Based Twofold Route Selection AODV Routing Protocol for Improved Communications on MANET for Industrial Automation, 46, 2021, 4063-4066. <https://doi.org/10.1016/j.matpr.2021.02.604>
- [3] Elbamby, M. S.; Perfecto, C.; Bennis, M.: et al. Toward Low-Latency and Ultra-Reliable Virtual Reality, IEEE Network, 32(2), 2018, 78-84. <https://doi.org/10.1109/MNET.2018.1700268>
- [4] Farshid, M.; Paschen, J.; Eriksson, T.: et al. Go boldly!: Explore Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR) for Business, Business Horizons, 61(5), 2018, 657-663. <https://doi.org/10.1016/j.bushor.2018.05.009>
- [5] Freeman, D.; Reeve, S.; Robinson, A.: et al. Virtual Reality in the Assessment, Understanding, and Treatment of Mental Health Disorders, Psychological Medicine, 47(14), 2017, 2393-2400. <https://doi.org/10.1017/S003329171700040X>
- [6] Howard, M. C.: A Meta-Analysis and Systematic Literature Review of Virtual Reality Rehabilitation Programs, Computers in Human Behavior, 70, 2017, 317-327. <https://doi.org/10.1016/j.chb.2017.01.013>
- [7] Jensen, L.; Konradsen, F.: A Review of the Use of Virtual Reality Head-Mounted Displays In Education and Training, Education and Information Technologies, 23(4), 2018, 1515-1529. <https://doi.org/10.1007/s10639-017-9676-0>
- [8] Kim, H. K.; Park, J.; Choi, Y.: et al. Virtual Reality Sickness Questionnaire (VRSQ): Motion Sickness Measurement Index in a Virtual Reality Environment, Applied Ergonomics, 69, 2018, 66-73. <https://doi.org/10.1016/j.apergo.2017.12.016>
- [9] Lee, E. A. L.; Wong, K. W.: Learning with Desktop Virtual Reality: Low Spatial Ability Learners are More Positively Affected, Computers and Education, 79, 2014, 49-58. <https://doi.org/10.1016/j.compedu.2014.07.010>
- [10] Makransky, G.; Terkildsen, T. S.; Mayer, R. E.: Adding Immersive Virtual Reality to a Science Lab Simulation Causes More Presence but Less Learning, Learning and Instruction, 60, 2019, 225-236. <https://doi.org/10.1016/j.learninstruc.2017.12.007>
- [11] Morina, N.; Ijntema, H.; Meyerbröker, K.: et al. Can Virtual Reality Exposure Therapy Gains Be Generalized to Real-Life? A Meta-Analysis of Studies Applying Behavioral Assessments, Behaviour Research and Therapy, 74, 2015, 18-24. <https://doi.org/10.1016/j.brat.2015.08.010>
- [12] Muhanna, M. A.: Virtual reality and the Cave: Taxonomy, Interaction Challenges and Research Directions, Journal of King Saud University-Computer and Information Sciences, 27(3), 2015, 344-361. <https://doi.org/10.1016/j.jksuci.2014.03.023>
- [13] Pan, X.; Hamilton, A. F. C.: Why and How to Use Virtual Reality to Study Human Social Interaction: The Challenges of Exploring a New Research Landscape, British Journal of Psychology, 109(3), 2018, 395-417. <https://doi.org/10.1111/bjop.12290>
- [14] Saposnik, G.; Cohen, L. G.; Mamdani, M.: et al. Efficacy and Safety of Non-Immersive Virtual Reality Exercising in Stroke Rehabilitation (EVREST): A Randomised, Multicentre, Single-Blind, Controlled Trial, The Lancet Neurology, 15(10), 2016, 1019-1027. [https://doi.org/10.1016/S1474-4422\(16\)30121-1](https://doi.org/10.1016/S1474-4422(16)30121-1)
- [15] Serino, M.; Cordrey, K.; McLaughlin, L.: et al. Pokémon Go and Augmented Virtual Reality Games: A Cautionary Commentary for Parents and Pediatricians, Current Opinion in Pediatrics, 28(5), 2016, 673-677. <https://doi.org/10.1097/MOP.0000000000000409>
- [16] Shin, D.: Empathy and Embodied Experience in Virtual Environment: To what Extent Can Virtual Reality Stimulate Empathy and Embodied Experience?, Computers in Human Behavior, 78, 2018, 64-73. <https://doi.org/10.1016/j.chb.2017.09.012>
- [17] Silva, J. N. A.; Southworth, M.; Raptis, C.: et al. Emerging Applications of Virtual Reality in Cardiovascular Medicine, JACC: Basic to Translational Science, 3(3), 2018, 420-430. <https://doi.org/10.1016/j.jacbts.2017.11.009>
- [18] Slater, M.: Immersion and the Illusion of Presence in Virtual Reality, British Journal of Psychology, 109(3), 2018, 431-433. <https://doi.org/10.1111/bjop.12305>

- [19] Smith, M. J.; Ginger, E. J.; Wright, K.; et al.: Virtual Reality Job Interview Training in Adults With Autism Spectrum Disorder, *Journal of Autism and Developmental Disorders*, 44(10), 2014, 2450-2463. <https://doi.org/10.1007/s10803-014-2113-y>
- [20] Tussyadiah, I. P.; Wang, D.; Jung, T. H.; et al.: Virtual Reality, Presence, and Attitude Change: Empirical Evidence from Tourism, *Tourism Management*, 66, 2018, 140-154. <https://doi.org/10.1016/j.tourman.2017.12.003>
- [21] Valmaggia, L. R.; Latif, L.; Kempton, M. J.; et al.: Virtual Reality in the Psychological Treatment for Mental Health Problems: An Systematic Review of Recent Evidence, *Psychiatry Research*, 236, 2016, 189-195. <https://doi.org/10.1016/j.psychres.2016.01.015>
- [22] Yiannakopoulou, E.; Nikiteas, N.; Perrea, D.; et al.: Virtual Reality Simulators and Training in Laparoscopic Surgery, *International Journal of Surgery*, 13, 2015, 60-64. <https://doi.org/10.1016/j.ijssu.2014.11.014>
- [23] Yung, R.; Khoo-Lattimore, C.: New realities: A Systematic Literature Review on Virtual Reality and Augmented Reality in Tourism Research, *Current Issues in Tourism*, 22(17), 2019, 2056-2081. <https://doi.org/10.1080/13683500.2017.1417359>