Scholar Publishing Group
International Journal of Art Innovation and Development
https://doi.org/10.38007/IJAID.2022.030302
ISSN 2789-7192 Vol. 3, Issue 3: 19-34

Image Processing Analysis and Research Based on 3D Animation Design

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Keywords: 3D Animation Design, Image Processing, Edge Detection, Image Enhancement

Abstract: With the continuous development of China's social economy and information science and technology, people's living standards have been further improved, and they have gradually entered a new era of network and informationization. More and more people are beginning to pursue the joy of spiritual life. People's work and study are inextricably linked to computers, especially in digital entertainment, which has developed rapidly in recent years. Under such circumstances, the Internet and computers have effectively promoted the further development of the animation industry to a certain extent. Animation design is no longer limited to traditional pen-based painting. Instead, the design of the animation is implemented by a computer device. Moreover, people's requirements for animation are no longer limited to traditional 2D animation, but more favored by the vivid 3D animation. The design of 3D animation is a fast-growing emerging industry. With the crazy launch of 3D animation and the popularity of 3D online games, people are fully aware of the huge cultural value and market value of the animation industry. Therefore, many countries and regions have positioned the 3D animation industry as a new economic growth point. The Chinese government has also begun to vigorously support and develop the 3D animation industry, and listed related research as an important part of the national science and technology development plan. Although the design and production technology of 3D animation is becoming more and more mature, there is still much room for improvement in the automation, fidelity and flexibility of animation design. Therefore, the theory and algorithm related to 3D animation design has become a research hotspot in the field of computer image processing in recent years. In view of this, this paper analyzes and studies the image processing based on 3D animation design. Through the 3D animation design and production process, Canny edge detection and image effect enhancement processing are proposed, and the quality of the obtained enhancement effect map is evaluated. The interpolation of the intermediate frame of the animation is discussed. The influence of the motion key frame in the model reconstruction and the performance of the intermediate frame generation are analyzed. The results show that the combination of 3D animation design and image processing can make the image achieve good results.

1. Introduction

People have now entered the information age, and to a certain extent, the rapid and effective processing of the required information will directly affect people's thinking and decision-making. As an important carrier for people to obtain information, the image processing technology is advanced, which determines the value of image processing. Computer image processing technology can help people accurately obtain the required information and accelerate the progress and development of human society. Digital image processing has experienced the development of hopping in just a few decades, and the advancement of special technology has influenced and led the development of various technologies in our lives, in technology, in education, and in medicine. The position of digital image processing in various industries and applications has risen to an indispensable degree unconsciously. It has gradually penetrated into the daily life of people from the nascent high-tech field, such as large and small supermarket goods coding across the country, weather information collection, road traffic monitoring, hospital body testing, monitoring and alarm systems for important departments, bank self-service cash dispensers, Internet media information transmission, video telephony video transmission technology, etc. People's quality of life is increasing, and the efficiency of factories and production is also leaps and bounds. These are inseparable from intelligent and automated digital image processing technology. At this stage and in the near future, digital image processing technology will continue to bring us even greater changes. Therefore, computer image processing technology has a meaning that cannot be ignored for social development and human progress.

The so-called digital image processing, also known as computer image processing, refers to a series of purposeful technical operations on digital images obtained by a computer processing system in order to obtain certain expected results and related data. In the early days of digital image processing technology, the purpose of digital image processing was to improve the quality of the image itself. It was mainly used to improve the visual quality of people [1]. With the continuous development of information technology and computer hardware and the expansion of the scope of application, the main purpose of processing and processing images at this stage has gradually changed from improving human vision to the following three aspects: (1) To improve the visual quality of the image, enhance or suppress some of the components we do not need in the image, and thus enhance the quality of the image, which is the main goal of digital image processing in earlier periods. (2) In order to make the computer analyze the image more conveniently and quickly, some special information contained in the image may be extracted, and the information may be a texture feature, a shape feature, or the like, or may be a boundary feature or a frequency domain feature. (3) Image data processing transformation, encoding and compression to facilitate image storage and transmission [2].

Regarding the field of image processing, many scholars are researching and exploring it. Digital image processing technology originated in the 1920s, when the first digital photo was transmitted using digital compression technology from London, England, to New York, USA [3]. Digital image processing was formed as a science in the 1960s [4]. Early image processing was the most important purpose to improve image quality. Since the 1964 American Jet Propulsion Laboratory used digital technology for image processing of a large number of lunar photos acquired by Voyager 7, more and more corresponding technologies were applied to image processing. The visual computing theory proposed by Marr in the late 1970s provided the leading idea for the theoretical development of computer digital image technology later [5]. In the late 1980s, people began to apply it to geographic information systems to study the automatic reading and automatic

generation of charts [6]. The development of digital image processing technology began in the early 1990s. Since 1986, wavelet theory and transformation methods have developed rapidly. It overcomes the inadequacies of Fourier analysis that cannot be used for local analysis. It is considered to be the crystallization of the work of harmonic analysis for half a century. In 1988, Mallat effectively applied wavelet analysis to image decomposition and reconstruction [7]. Wavelet analysis is considered to be a major breakthrough in mathematical methods for signal and image analysis, followed by the rapid development of digital image processing technology [8]. So far, image processing technology has been widely recognized in many application fields and has made significant pioneering achievements, making image processing a new subject with remarkable attention and great prospects. It has also attracted the attention of many scholars in China. At present, chaos theory is still in the initial stage of image recognition research. Wang Yushi [9] used chaos theory and method to learn the visual perception mechanism of humans and give an iterative based image feature generation. Methods, two-dimensional and three-dimensional chaotic attractors are obtained, and they are used as image features. Face recognition, handwritten Chinese characters and leaves are taken as objects, and image recognition and analysis are carried out respectively. Chen Zhiguo and Xu Chunhuan [10] introduced the basic principles of image coding and the current relatively new coding techniques in the research and application of the image coding technology published, and summarized the image coding technology. Yan Juan [11] focused on various digital image smoothing techniques in the spatial domain. Li Quanli [12] and others introduced the principle of histogram modification technology and the principle of histogram equalization and prescribed contrast finishing, and fully elaborated the research focus. He Lei [13] classifies image restoration techniques, using the elimination or reduction of image blur, image annoyance and noise, etc., to obtain the original real image as much as possible. Lin Xiaohe and Qiu Xiaojia [14] discussed the application of image analysis technology in medicine, and also prospected the future medical image analysis technology. Zhang Junlan [15] and others analyzed the digital image processing technology to improve the understanding of digital images. In 2012, Zhang Wei [16] proposed the development direction of future image processing technology, that is, the future digital image technology will certainly develop toward high precision and high speed, and the requirements for real-time image processing on processing equipment will also be corresponding improved, more intelligent and convenient.

With the development of computer technology, image processing technology has penetrated into all aspects of our lives. Among them, the application of entertainment and leisure has been deeply rooted in people's hearts [17]. The application of image processing technology in entertainment mainly includes: movie special effects production, computer electronic games, digital cameras, video playback, digital television and so on. However, image processing technology is often only used to research and apply two-dimensional images. When the image data is large, not only can not fully display the real photos, but also can not show the details. The emergence of 3D animation technology can better solve the problem that this two-dimensional image can't solve. If applied to the field of image processing, 3D animation technology will enable people to see graphic images more vividly, concretely and clearly [18]. And the image processing effect is good, the speed is fast, and it also has high processing precision.

3D animation technology is a new technology produced with the continuous development of computer technology. It is a work of close integration of art and technology [19]. In recent years, 3D animation design techniques, such as facial expressions and animation enhancements, have received much attention. In general, it is mainly used in the following aspects: (1) Three-dimensional online games [20]. In the design of character characters in 3D online games, it is

not only necessary to design the movement of the human body, but also to design a three-dimensional facial expression animation. In various realistic game scenes, if the facial information of the person in the game is replaced with the user's own facial information, the facial expression and the avatar structure are appropriately exaggerated. The creation of this game will become more realistic and humorous, which will add more interesting effects, so that users can immerse themselves in this pleasant game process and realize the entertainment effect of this game. (2) Auxiliary teaching. With the popularity of computer applications, computers have naturally become an important tool for teaching [21]. Following the teacher learning in computer video is also an important way of modern education, teaching and knowledge acquisition. But often tired of these boring video content, unable to continue learning or concentration, efficiency tends to become very low. Suppose, if the characters in the video are treated in an exaggerated way and the humor effect of the video is added, then the students' learning enthusiasm will be greatly changed, and the process of learning can always maintain a relaxed and happy mood. And the vivid characters are more likely to impress people, which can make students acquire knowledge more firmly in the state of pleasure. (3) Film and television entertainment. The real character performance is presented to the audience in the form of 3D cartoon animation, and without losing the characteristics of the original character, the audience can easily recognize the character in the cartoon animation form as an artist in real life [22]. In addition, the facial expressions of the characters in the animation are appropriately exaggerated, which not only increases the sense of humor, but also more accurately and clearly expresses the emotional changes of the animated characters. (4) Remote conference and communication. Video chat through mobile phones has gradually become the focus of people's attention. Video transmission can express the emotions of people more realistically than text transmission. If the characters passed in cartoon form, it can increase the entertainment effect [23], and if you are chatting with strangers, you can keep your personal portrait information and protect your portrait privacy. Communicating through animation has created a new development platform for this multimedia technology. Compared to live shooting [24], 3D animation technology has the following characteristics: (1) The modifiability is strong, the quality requirement is more controllable in the process of 3D animation production, and the lens with too high real cost can be realized by 3D animation to achieve the purpose of reducing cost. (2) Shots that cannot be completed, are dangerous, and cannot be reproduced can be completed by 3D animation [25]. (3) It has powerful styling function and excellent digital special effects, and can provide users with a variety of flexible and convenient styling tools. (4) When the human body model is made by computer, it can shape the facial expression changes such as the shape of the human mouth, and at the same time, the curved skin on the outer layer of the human bone can control the movement of the human body by adjusting the movement of the bone, and can be very natural. An elastic reaction such as systolic relaxation occurs. 5) With realistic particle effects, users can generate natural phenomena such as rain and snow through particles. (6) Since the expressive power of the 3D animated picture is not limited by the weather, the season, and the physical condition of the live view equipment, the camera of the virtual world can be regarded as an ideal camera, but the final picture effect depends on the producer’s technical level.

Throughout the current trend of 3D animation technology, it is widely used in movies, animation, games, advertising, virtual reality and augmented reality. In the face of comprehensive scientific technology and high-speed development of social economy, flexible expressions and vivid effects creativity play an important role in the animation design, and can more vividly express image information. Therefore, 3D animation design can be applied to the analysis and research in the field of image processing.

Although the design and production technology of 3D animation is becoming more and more mature, there is still much room for improvement in the automation, fidelity and flexibility of animation design. Therefore, the theory and algorithm related to 3D animation design has become a research hotspot in the field of computer image processing in recent years. In view of this, this paper proposes the application of Canny edge detection algorithm and the image effect enhancement processing method for 3D animation design and production, and objectively evaluates the image quality of the enhanced image obtained by the experiment. Then we interpolate the intermediate frame interpolation and intermediate frames, and analyze the influence of motion key frames in model reconstruction and the performance of intermediate frame generation. The experimental results show that the combination of 3D animation design and image processing can make 3D images achieve good results. The proposed method has good practicability and provides a good reference for the combination of 3D animation design and image processing technology.

2. Proposed Method

2.1. 3D Animation Intermediate Frame Interpolation

Key frame animation is a basic mode in animation production today. Whether it is 2D animation or 3D animation, they are continuous and vivid animation effects formed by a series of static frames of an animated character. Static signs are pressed time-ordered. The most cumbersome and complex part of keyframe animation is intermediate frame interpolation. Keyframes alone cannot produce continuous animation effects. Interpolation between adjacent keyframes is required to generate a considerable number of intermediate frame images, so that the designed animation character's motion pose can smoothly transition between keyframes. Create a vivid and smooth animation sequence. The production level and efficiency of the intermediate frame will directly affect the quality of 3D animation.

In the process of linear interpolation, it will cause severe distortion of the intermediate frame. In order to avoid the distortion, the deformation gradient vector model is adopted. The model considers the deformation information of the mesh vertices and adjacent vertices at the same time, and embodies the local cross-correlation relationship in the deformation, which is an essential description of the deformation information. The matrix polarization decomposition algorithm is used to decompose the transformation matrix of each triangle into a nonlinear rotation component and the current stretch scaling component, and interpolate separately, so that a smooth and reasonable intermediate frame animation effect can be generated. The specific intermediate frame animation automatic interpolation algorithm is as follows:

Extracting the deformation information of adjacent key frames f

The key frame pose of the 3D model is designed by the 3D mesh model's mesh deformation algorithm. Suppose that the triangle mesh model of the animated character contains n vertices and m triangles, and the affine transformation from the starting pose to the ending pose of the j-th triangle in the mesh model is Φ_j. Φ_j consists of a translation vector dj and a 3×3 matrix Tj, which contains rotation, scaling and miscut components in the affine transformation, and represents the deformation information of the affine transformation. The matrix Tj is calculated from the vertex positions of the start posture and the end posture according to each of the triangles. The matrix sequence $\{T_1, T_2, \mathrm{L}\ , T_m\}$ represents the deformation information of each triangle in the mesh model from the beginning of the intermediate frame to the termination of the intermediate frame. The

elements in each matrix in the deformation information $\{T_1, T_2, \text{L}\ , T_m\}$ can be stretched by columns, arranged into a 9m × 1 vector f, which is called a deformation gradient vector, and m is the number of triangular slices in the grid. The gradient vector f of the deformation information can be expressed as a linear combination of the grid top positions of the termination pose mesh model:

$$f = GX \quad (1)$$

Where $X = (x_1, \text{L}\ , x_p, y_1, \text{L}\ , y_p, , z_1, \text{L}\ , z_p)^T$ is a 3p × 1 vector, indicating the vertex position of the termination pose mesh model. The 9m × 3p transformation matrix G is completely determined by the vertex position of the starting attitude mesh model. Where p=m+n, where n is the total number of mesh vertices. There are only 4 non-zero elements in each row of matrix G, which is a sparse matrix. When solving the intermediate frame X, since it is a non-compatible solution, it is usually solved by the least squares teni method:

$$x(t) = \min_x \|Gx(t) - f(t)\|^2 \quad (2)$$

Since the coefficient matrix G is a sparse matrix, the least squares solution can be solved by the reflection Newton iteration algorithm when solving the above formula, which can greatly reduce the time required for the operation.

Using intermediate interpolation to generate intermediate frames

If a non-singular matrix can be uniquely decomposed into the product of an orthogonal matrix and a positive definite symmetric matrix, then this decomposition is called polarization decomposition. Therefore, each 3X3 matrix Tj is polarization-decomposed into a spatial rotation matrix and a spatial scaling matrix, that is, the form of Tj=RjSj, and then the rotation component Rj and the scaling component Sj are separately processed to obtain a deformation corresponding to the intermediate frame. The method of the rule vector, and thus the intermediate frame mesh model. The advantage of this method is that the deformation of each triangle, that is, the transformation matrix Tj is decomposed into a rotation component and a scaling component, so that its geometric meaning is clear, providing an animator with additional intermediate frame animation controls to produce different animated visuals and different animated effects.

The process of matrix polarization decomposition for Tj is as follows: Let $T_j = R_j S_j$, since R_j is an orthogonal matrix, then:

$$T_j^T T_j = S_j^T (R_j^T R_j) S_j = S_j^T S_j \quad (3)$$

Diagonalization of the positive definite matrix $T_j^T T_j$ can be obtained:

$$S_j^T S_j = T_j^T T_j = U^{-1} \begin{bmatrix} \lambda_1 & & \\ & \lambda_2 & \\ & & \lambda_3 \end{bmatrix} U \quad (4)$$

From this, the positive definite symmetric matrix Sj and the rotation matrix Rj can be obtained:

$$S_j = U^{-1}\begin{bmatrix} +\sqrt{\lambda_1} & & \\ & +\sqrt{\lambda_2} & \\ & & +\sqrt{\lambda_3} \end{bmatrix} U \quad (5)$$

At 0 < t < 1, the stretch scale matrix Sj(t) of the intermediate frame can be directly derived from the matrix linear interpolation:

$$S_j(t) = (1-t)I + tS_j, t \in [0,1] \quad (6)$$

The rotation matrix Rj(t) of the intermediate frame can be calculated by the quaternion spherical linear interpolation algorithm, and the quaternion q1 corresponding to the rotation matrix Rj is calculated at time t=1, and the constant rotation matrix Rj is obtained at t=0. The corresponding quaternion is q0=(1, 0, 0, 0). Then 0 < t < 1 The quaternion q (t) corresponding to the rotation matrix Rj(t) of the intermediate frame can be calculated according to the quaternion spherical interpolation formula:

$$q(t) = q_0 \exp(t \cdot \log(q_0^{-1} q_1)) = \exp(t \cdot \log(q_1)) \quad (7)$$

Then convert q(t) to the corresponding rotation matrix Rj(t) and get $T_j(t) = R_j(t)S_j(t)$. Then calculate the vertex position of the intermediate frame mesh model at time t. For the overall displacement of the mesh model, the displacement of the geometric mean points of the vertices of the mesh model in the key frame can be calculated, and the overall displacement is linearly interpolated to obtain the overall displacement of each intermediate frame mesh model, and the middle frame mesh model is constructed.

2.2. Canny Edge Detection

Under normal circumstances, after the image is processed through pre-processing, the blurred image with the contrast is not strong and the noise is much more optimized for a clearer image with stronger contrast and less noise, but this is only the outer layer of the image, and does not get the deeper feature information of the image. The edge refers to the part of the image where the local brightness changes most prominently. As the most basic feature of the image, it is an important basis for image analysis such as image segmentation, texture feature extraction and shape feature extraction. Edge detection is the most critical step in obtaining image depth information. The Canny edge detector is the first derivative of the Gaussian function and is the optimal approximation operator for the product of signal-to-noise ratio and localization. There are three main criteria for Canny edge detection: 1) High signal to noise ratio criteria. That is, the probability that the non-edge point is determined as the edge point or the edge point is determined to be the non-edge point is minimized, and both of these probabilities decrease monotonically as the signal-to-noise ratio increases; 2) High positioning accuracy criteria. That is, the distance between the detected edge and the actual edge point is the smallest, so that the positioning accuracy is the highest; 3) A single edge response criterion. That is, there must be a low number of responses to the same edge, and the response of the false edge is to be suppressed to the utmost extent.

The basic idea of the Canny edge detection algorithm is to find the local maximum of the image gradient, which is calculated using the first-order differential of the Gaussian function. The steps in

edge detection are as follows:

(1) The image is first smoothed by a Gaussian filter, and the original image is smoothed and denoised by a one-dimensional Gaussian function of the following formula to obtain a smoothed image $I(x,y)$.

$$IG(x,y)=(\frac{1}{2\pi\sigma^2})\exp(-\frac{x^2+y^2}{2\sigma^2})$$
$$I(x,y)=[G(x)G(y)]*f(x,y) \quad (8)$$

Where * is the convolution, $f(x,y)$ is the original image, and σ is the scatter parameter of the Gaussian function, which is used to control the degree of smoothness.

(2) The finite difference of the 2X2 neighborhood first-order partial derivative is used to calculate the amplitude and gradient direction of the smoothed image $I(x,y)$.

$$M(x,y)=\sqrt{g_x^2(x,y)+g_y^2(x,y)}$$
$$\theta(x,y)=\arctan[g_x(x,y),g_y(x,y)] \quad (9)$$

(3) The non-extreme suppression of the gradient amplitude is such that only the point where the local variation of the amplitude on the edge is the largest is retained.

(4) The double closed value algorithm is used to detect and join the edges, that is, output the detected image edges.

The edge detection algorithm is characterized by the use of two different thresholds to detect weak and strong edges, respectively, and to include weak edges in the output image if and only if the weak and strong edges are connected. Therefore, it is not easy to be disturbed by noise during detection, and it is easier to detect a true weak edge.

2.3. 3D Animation Effect Image Enhancement

(1) Principle

There are probably three steps in the enhancement operation of the three-dimensional animated feature information. Firstly, the global histogram equalization algorithm and the local histogram equalization algorithm are used to equalize the 3D stereoscopic feature information; secondly, the objective function of the 3D stereoscopic image enhancement effect is calculated; thirdly, the calculation is based on the enhanced objective function As a result, the histogram specification operation method is used to enhance the feature information of the three-dimensional animation.

Suppose a three-dimensional animation I of size M×N contains L gray levels, where the gray value of n feature information pixel points is r, and the global histogram equalization algorithm is used to perform the following mapping operations on 3D stereo animation:

$$\begin{cases} s=T(r) \\ 0\le r\le L-1 \end{cases} \quad (10)$$

Assuming that the size of the sliding window of the three-dimensional animated feature information of the adaptive histogram equalization algorithm is expressed as W × W, the local mapping function expression of the 3D stereoscopic feature information is:

$$m(i) = \frac{255 \times cdf(i)}{W \times W} \quad (11)$$

In the above formula, cdf(i) represents the cumulative distribution function of the local histogram of the sliding window of the three-dimensional animated feature information; the derivative thereof represents the 3D stereoscopic feature information histogram hist(i).

It is assumed that the histogram of the input three-dimensional animated feature information is represented as h_{input}; the globally equalized three-dimensional animated feature information histogram is represented as h_{HE}; the partially equalized three-dimensional animated feature information histogram is represented as hCLAHE, which is to be obtained The histogram after the three-dimensional animation enhances the image processing effect is represented as h_{output}. The objective function of the three-dimensional animation to enhance the image processing effect is:

$$h_{output} = \arg\min \left\| h - h_{input} \right\| + \alpha \left\| h - h_{HE} \right\| + \beta \left\| h - h_{output} \right\| \quad (12)$$

Where α and β represent the regularization coefficients of the three-dimensional animated feature information.

Using the sum of the squares of the Euclidean norm to simplify the above expression, the following formula is obtained:

$$h_{output} = \arg\min \left\| h - h_{input} \right\|_2^2 + \alpha \left\| h - h_{HE} \right\|_2^2 + \beta \left\| h - h_{output} \right\|_2^2 \quad (13)$$

According to the above formula, the input three-dimensional animation I and the three-dimensional animation enhanced image processing effect histogram houtput are specified, and finally the three-dimensional animation feature information is enhanced. In summary, the principle of the method for enhancing the image processing effect of the three-dimensional animation is obtained, and the three-dimensional animated image is enhanced according to the principle.

(2) Three-dimensional animated feature information smoothing based on bilateral filtering

Firstly, the three-dimensional animated feature information is subjected to range filtering and spatial domain filtering preprocessing respectively. Secondly, the bilateral filtering discrete form of the three-dimensional animated feature information is calculated, and the Gaussian kernel function of the three-dimensional animated feature information is obtained. Then the Gaussian kernel function is used to calculate the result. Eliminate the noise contained in the 3D animation feature information. The specific description of the process is as follows.

The spatial domain filtering expressions of the three-dimensional animated range filtering and the three-dimensional animated animation are:

$$\begin{aligned} h(x) &= \frac{1}{K_b,(x)} \int_{-\infty}^{+\infty} f(x)\delta(f(\xi), f(x))d\xi \\ h(x) &= \frac{1}{K_d,(x)} \int_{-\infty}^{+\infty} f(x)c(\xi, x)d\xi \end{aligned} \quad (14)$$

Wherein, $\delta(f(\xi), f(x))$ represents the brightness similarity of the feature information of the

three-dimensional animated animation; $K_b,(x)$ and $K_d,(x)$ represent the normalization coefficient of the feature information of the three-dimensional animated animation; $c(\xi, x)$ represents the Euclidean distance between the pixel points x and ξ of the three-dimensional animated feature information; d represents the weight of the three-dimensional animated feature information.

Assuming that the three-dimensional animated feature information input and output functions are represented by R and R', respectively, the expression of the bilaterally filtered discrete form of the three-dimensional animated feature information is as follows:

$$R' = [k, j] = \sum_{m=-p}^{p} \sum_{n=-p}^{p} B[m, n, k, j] R[k-m, j-n] \tag{15}$$

Where p represents a pixel of the 3D animation feature information; m represents the variance of the 3D animation feature information; n represents the 3D animation feature information standard deviation; B[m, n, κ, j] represents the Gaussian kernel function of the three-dimensional animated feature information, its calculation expression is as follows:

$$B[m, n, k, j] = \frac{\exp(-\frac{m^2+n^2}{2\sigma_\delta^2} - \frac{R[k-m, j-n]}{2\sigma_\xi^2})}{R(k, j)} \tag{16}$$

In the above formula, σ represents a three-dimensional animated feature information scale parameter.

The above equation is used to smooth the three-dimensional animated feature information from the geometric and photometric domains to eliminate the influence of noise and maintain the three-dimensional animated feature detail information.

3. Experiments

3.1. Data Source

The experimental images are from Google search and have universal applicability.

3.2. Image Processing Enhancement Effect Objective Evaluation

The enhanced image quality was evaluated using image contrast, signal to noise ratio, and information entropy.

The image contrast is calculated as follows:

$$C_{\mathrm{i},\ \mathrm{j}} = \frac{1}{N} \sum_{n=-k}^{n=k} \sum_{m=-k}^{m=k} \left\| I_{i,j} - I_{i+m, j+n} \right\| \tag{17}$$

Where $I_{i,j}$ is the gray value of the central pixel and N is the number of pixels in the image local block. The contrast of an image is defined as the average of the contrast of all local blocks in the image.

The signal-to-noise ratio of the image is calculated as follows:

$$R = \frac{G_t - G_b}{\sigma} \quad (18)$$

Where G_t is the maximum gray value of the image target area, G_b is the gray mean of the image background area, and σ is the standard deviation of the pixel gray value of the image background area.

The calculation formula of image information entropy is as follows:

$$H = -\sum_{i=0}^{M} p(k) \log_2 p(k) \quad (19)$$

Where $p(k)$ is the probability density of gray level k and M is the largest gray level.

3.3. System Environment

The image processing analysis and research based on 3D animation design proposed in this paper is designed and implemented on ordinary PC.

Hardware configuration:

CPU: Pentium(R) Dual-Core CPU E5800 @ 3.20GHz

Memory: 4G

Software configuration:

System: 64 bit win10

Development environment: MATLAB 2014B

4. Results and Discussions

Result 1: Edge detection

The Canny edge detection algorithm is used to detect local significant changes in the image. The image edge detection process contains two basic contents: firstly, the edge points reflecting the gray level change are extracted, and the discontinuity of the local characteristics is detected. The more important part of the process is to identify the non-edge points and edge points by appropriate methods; then these discontinuous edges are joined to make it a complete curve. The most critical part of the process is to eliminate some edge points or fill boundary break points. The experiment is used for the edge detection, as shown in Figure 1. The effect of the edge detection is shown in Figure 2.

Result 2: Enhanced image processing

The image enhancement algorithm can improve the overall and local contrast of the image, highlighting the detailed information of the image, making the enhanced image more in line with the visual characteristics of the human eye and easy for machine recognition. Amplifying noise should be avoided while enhancing the image. If the noise cannot be effectively suppressed, the noise is amplified during the image enhancement process, which affects the image quality.

Figure 1. Edge detection original image

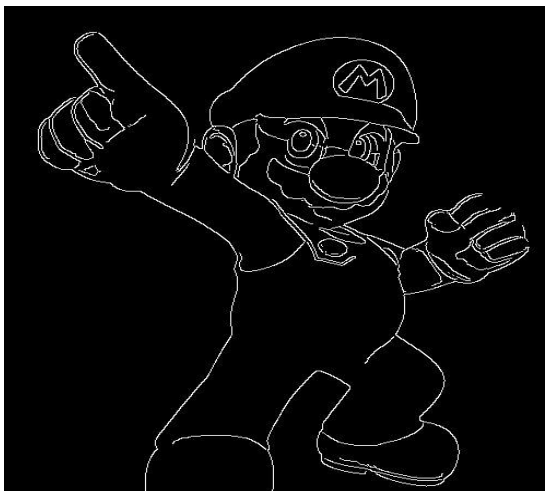

Figure 2. Edge detection effect diagram

Figure 3. 3D animation original picture

Figure 4. Effect enhancement results

Through the image enhancement method of this paper, the three-dimensional original image is shown in Figure 3, and the effect enhancement map is shown in Figure 4. The experimental images were calculated using the contrast, signal-to-noise ratio and information entropy calculation formulas of the above-mentioned images. The calculation results are shown in Table 1.

Table 1. Objective evaluation results of image quality

	Contrast	Signal to noise ratio	Information entropy
Original	9.0	7.8	1.9
Evaluation result	30.5	21.9	4.5

The essence of image enhancement is to improve the overall and local contrast of the image according to the distribution law of the gray value of the pixel of the original image in a certain range of gray space. At the same time, by combining the visual characteristics of the human eye, noise suppression, image information entropy maximization and brightness preservation, the enhanced image has better image quality. It can be seen from the data in Table 1 that the enhanced image has a better visual effect, can significantly improve the contrast of the original image, and has a good signal to noise ratio and information entropy.

Result 3: Motion keyframe

In computer animation, human character animation is an important part, but because the human body contains many degrees of freedom and high dimensionality, it is very difficult to create a realistic and realistic motion model. Human character animation has always been a difficult point in computer animation technology. Realize the extraction of key frames of motion data. The motion reconstruction part is reconstructed by using the quaternion spherical interpolation method. The reason why the quaternion interpolation algorithm is selected is that it can ensure that the difference between the adjacent key frame poses is large, and the smoother intermediate frame animation can also be generated by interpolation. The reconstruction error size is related to the number of key frame extractions. The reconstruction error curve for the 150-frame walking motion is shown in Figure 5.

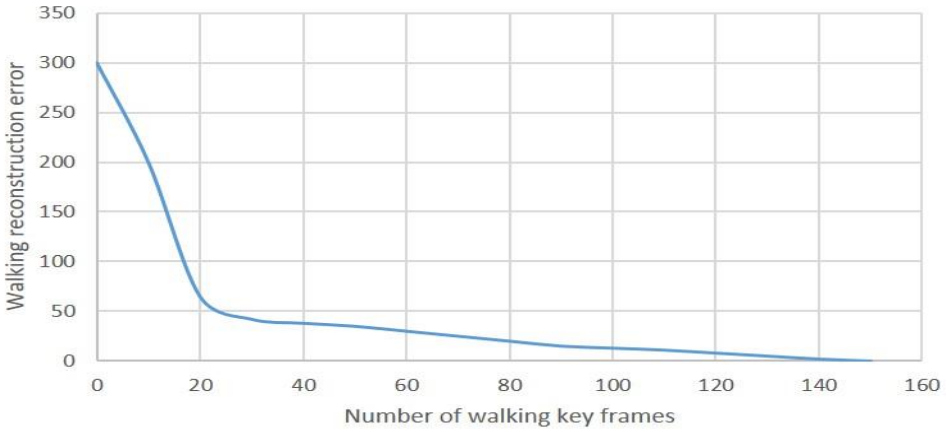

Figure 5. Walking motion reconstruction error curve

The error between the original motion and the reconstructed motion sequence (reconstruction error) is represented by the difference between the human body posture error position and the human joint motion rate, and the reconstruction error is represented by the average interframe distance between the original frame and the reconstructed frame. The reconstruction error is closely related to the number of key frame extractions and the rate of human joint motion. Generally, the fewer key frames are extracted, and the reconstruction error is larger. It can be seen from Figure 5 that the smaller the number of extracted key frames, the larger the reconstruction error.

Result 4: The generation time of the intermediate frame
The time for each network model to generate a single intermediate frame is shown in Table 2.

Table 2. Running time of a single tween-frame animation

Mesh model	Number of triangles	Single intermediate frame generation time (s)
Human body mesh model	11995	17.8
Horse mesh model	16134	23.9
Face mesh model	8637	11.3

Due to the introduction of quaternion nonlinear interpolation, the intermediate frame nonlinear interpolation algorithm can ensure that even if the animated characters have large differences in poses in adjacent key frames, a reasonable and smooth intermediate frame can be generated. The algorithm can effectively reduce the number of hand-drawn key frames and improve the animation production efficiency. Limited to the interpolation problem between adjacent key frames, the interpolation problem between multiple key frames has not been involved. As a next step, we can consider the automatic optimization of multiple key frames by using quaternion theory combined with spline function method. Interpolation makes the automatically generated animation sequence more smooth in the vicinity of the key frame, and the quality of the animation is further improved.

5. Conclusion

To a certain extent, the Internet and computers have effectively promoted the further

development of the animation industry. Animation design is no longer limited to the traditional way of painting with pens, but through the computer device to achieve animation design. Moreover, people's requirements for animation are no longer limited to traditional 2D animation, but more favored by the vivid 3D animation. The design of 3D animation is a fast-growing emerging industry. Although the design and production technology of 3D animation is becoming more and more mature, there is still room for improvement in the automation, fidelity and flexibility of animation design. Therefore, the theory and algorithm related to 3D animation design has become a research hotspot in the field of computer image processing in recent years.

Aiming at the shortcomings of 3D animation research in the field of image processing and the defects of 3D animation technology in terms of image fidelity and automation, this paper mainly studies the main aspects of 3D animation design and production. This paper proposes the application of Canny edge detection algorithm and the image effect enhancement processing method, and objectively evaluates the image quality of the enhanced image obtained by the experiment. Then we interpolate the intermediate frame interpolation and intermediate frames, and analyze the influence of motion key frames in model reconstruction and the performance of intermediate frame generation. The experimental results show that the combination of 3D animation design and image processing can make 3D images achieve good results. The proposed method has good practicability and provides a good reference for the combination of 3D animation design and image processing technology.

Funding

This article is not supported by any foundation.

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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