Interactive Optimization of 3D Interface In Digital Media

YipingZhang1*, Jan Kurzinger2, Kolja Wilker2
1.Sino-German Institute of Design and Communication, Zhejiang Wanli University, Zhejiang 315107, China
2. DFI College of Communication Art and New Media, Hamburg, 20357 Germany
YipingZhang E-mail:zhangyiping952@163.com
Jan KurzingerE-mail:wangting55171@163.com
Kolja Wilker E-mail:liuliu7456@126.com

Abstract: In order to improve the interaction performance between users and 3D interface in digital media, the optimization of 3D interface interaction in digital media is studied. Based on the results of ray tracing rendering of 3D visual interface, the optimization model of 3D interface interaction in digital media is constructed by taking the visual attention allocation of the final layout of man-machine interface in digital media as the objective function, and man-machine constraints are added into genetic algorithm. In the process of solving the model optimization problem, the genetic algorithm negates the gene that does not carry the man-machine constraint characteristics, and uses the particle swarm optimization algorithm to optimize the genetic algorithm, so that the genetic algorithm can quickly obtain the optimal solution of the optimization model. The experimental results show that this method can improve the user's gaze time for digital media software, and the user's satisfaction with the use of the software is high.

Keywords: Digital media; 3D interface; interaction; optimization; genetic algorithm; particle swarm optimization algorithm

Tob Regul Sci.™ 2021;7(5):2226-2243
DOI: doi.org/10.18001/TRS.7.5.137

1. Introduction

Digital media is a kind of technology that uses CD-ROM media, network media, mobile media to achieve information exchange. Compared with traditional media technology, this technology has more abundant forms of expression, high efficiency, simple expression, and is not limited by time and space. Digital media also has the characteristics of interactivity.

The way of communication between people has developed from the form of text communication to the diversified form of communication in the era of digital media. People can obtain information through a variety of channels and realize the communication between people. Digital media is stored in the computer in the form of bits and propagated and processed. In the field of digital media, it is easier to achieve interactive performance. Computer based man-machine interaction is also a significant feature of digital media [1]. Digital media can process text, image, sound and other information, so it can better meet people's needs of media diversity in information exchange. The audience can actively participate in information dissemination, and real-time information exchange can be realized between the disseminator and the audience. The roles of source and sink can also be changed at any time, and the two-way communication tends to be more personalized. Interaction design began to appear and develop after the rise of the Internet in the 1990s. The essence of interaction design is to use products and services to promote the communication between any product and people, so as to establish a connection between products and users. It can not only meet the user's needs, but also enrich the user's experience, improve the utilization rate of the product, improve the use effect of the product, and improve the user's satisfaction. Under the background of the continuous development of various technologies and the diversification of new media forms, interaction design has obtained new development. The traditional interaction mode has gradually faded [2-4], and new interaction modes have emerged. Interaction design has also developed from the era of character input and output based on symbols and the era of graphic input and output based on visual perception to the current stage of multi sensory interaction. The human-computer interaction interface is more humanized, and the efficiency and quality of information exchange are improved. It can comprehensively apply people's various senses and perception abilities. It not only has the function of multimedia terminal information input and output, but also combine with virtual reality technology to make users feel the real scene and bring rich and colorful experience to users. Man-machine interaction has developed from simple computer desktop system interaction to mobile device interaction.At present, it has developed from mobile interaction to interaction under intelligent environment and virtual environment based on Intelligent Technology [5], and even emotional interaction has appeared.The diversification of man-machine interaction mode is inseparable from the development of science and technology. It is precisely because of the emergence and development of various new technologies that man-machine interaction mode has been innovated, and the diversification and intelligent development of man-machine interaction mode can also bring users a new rich and colorful interactive experience. The common man-machine interaction methods include entity keys, keyboard input, screen gestures, visual sound, touch and other feedback, voice interaction and so on. In the era of digital media, there are new ways of man-machine interaction in multimedia terminals.

The research of virtual reality technology in Europe is mainly supported by many plans of the European Union, and the development and application of virtual reality are actively carried out in Britain, Germany, Sweden, Spain, the Netherlands and other countries. In Germany, represented by FHG-IGD and GMD, they are mainly engaged in the perception of virtual world, the control and display of virtual environment, the remote control of robot and the application of virtual reality in space. The IGD test platform in the Netherlands is mainly used to evaluate the impact of virtual reality on future systems and interfaces [6], providing users and producers with access to advanced visual simulation technology and virtual reality. A team of researchers from the University of York and the University of Warwick in the UK developed the helmet "Virtual Cocoon", which provides virtual information and stimulation to the five senses of human beings. On March 4, 2009, the physical model of virtual cocoon helmet was opened at the new generation technology exhibition "Pianees 09" held in London, UK. Compared with other developed countries, China's virtual reality technology started late, and there is a certain gap in technology, but it has attracted the attention of the relevant departments of China's government, and timely formulated the research plan of virtual reality technology according to the national conditions of China. Domestic research institutions of virtual reality are mainly some colleges and universities, such as the State Key Laboratory of CAD &CAM of Zhejiang University, which takes the lead in applying for the project of "basic theory, algorithm and implementation of virtual reality". It promotes the establishment of virtual environment, natural man-machine interaction, augmented reality, distributed virtual reality and the application of virtual reality in product innovation. The school of information science and technology of Tsinghua University has carried out relevant research on virtual reality and telepresence, such as spherical screen display and image follow-up. And Tsinghua University Academy of fine arts independently developed based on projection dynamic capture demonstration equipment and multi-channel ring screen display. The school of information engineering of Xi'an Jiaotong University has carried out relevant research on the key technology of virtual reality stereoscopic display technology [7]. Virtual Reality Laboratory of Beijing University of Science and Technology has been engaged in virtual reality research for many years, and successfully developed a pure interactive car driving simulation training system. The multi-channel stereoscopic ring screen projection display system of Jiangnan University and Wuhan University of technology, with the help of VR-Platform technology platform, carries on the research of virtual display of product prototype.

In the process of digital media development, the characteristics of its interaction mode are gradually evolved in the development of digital media technology. It is a behavior mode of digital media products formed under the premise of user operation. With the continuous innovation of interaction mode in recent years, the interaction mode in the new era is mainly reflected in three aspects, namely object, space and interaction interface. As for its interactive mode, it has been changed by the innovation of digital media creators, expressing the creativity. In this way, the audience and user groups will have a new experience and enrich the use of digital media. The era of digital media inherits and develops all the contents of traditional media, and also includes all the contents of new media. Digital media is a combination of traditional media and new media. The content forms of this media are naturally diversified and enriched [8], and it has more characteristics of the times. It is the use of the latest science and technology, especially information technology, to realize the goal of information communication in the new era. Whether it's TV, radio, newspaper, record, etc., in the era of traditional media, or digital TV, digital radio, SMS, mobile TV, network, touch media, car TV, building elevator advertising, microblog, Wechat and media related to new technology in the era of new media, they are all included. With the development of three-dimensional technology, three-dimensional interaction has become very common [9]. People are already very familiar with the perception of three-dimensional space. Three-dimensional interaction can provide users with great convenience and freedom, and users will naturally gain better experience when they use it conveniently and quickly.

In recent years, with the popularity of mobile Internet, the design of mobile terminal has been paid more attention, and its interface design and interaction process is the core problem. Because people are involved in the process of interface interaction, the interaction efficiency and reliability become changeable and complex. It is influenced by the known, unknown or unascertained factors, such as human's recognition ability, reading process, comfort and system function, as well as personal knowledge, experience and preferences. Among them, two-dimensional perception and three-dimensional space coordination in the process of man-machine interaction are equally important, affecting human comfort. From its mechanism, genetic algorithm is a natural combinatorial optimization method, which has obvious advantages over other heuristic search methods. Previous scholars in different industries have done some research on the space utilization of genetic algorithm in space segmentation and space operation. In 1986, Dawkins proposed interactive evolutionary algorithm; in 2001, Qian Zhiqin proposed a man-machine interaction genetic algorithm, and in 2013, Fan Wen et al proposed an ant colony algorithm in line with man-machine characteristics, fully considering the three constraints of man-machine constraints in the algorithm. However, the two-dimensional constraints in man-machine interaction are not discussed.

This paper studies the optimization of three-dimensional interface interaction in digital media, establishes the optimization model of three-dimensional interface interaction, and obtains the optimal solution of the model by using particle swarm optimization algorithm and genetic algorithm. Experiments show that this method has high effectiveness of three-dimensional interface interaction optimization, and improves the user satisfaction with the use of digital media software.

2. Optimization method of 3D interface interaction

2.1 Ray tracing rendering of 3D visual interface

Rendering plays a very important role in the interactive optimization of digital media 3D interface, which is the guarantee of visual effect and quality. In order to make ray tracing algorithm deal with complex scenes, we must improve the efficiency of ray scene intersection test. The main ways are: reducing the number of rays; reducing the times of intersection; improving the speed of intersection; using parallel algorithm. In the above ways, reducing the number of rays will lead to the decline of image quality [10]. Using parallel algorithm needs the support of other software and hardware, so improving the speed of intersection and reducing the times of intersection become the focus of ray tracing algorithm.

Environment mapping is an effective method to improve the speed of intersection in image space. The so-called environment mapping is to build a cube with a certain viewpoint as the fixed center, which is used to record the projection of the surrounding environment on the surface of the cube. In this way, when ray tracing, it can replace the previous huge ray tracing tree, and obtain the reflection ray and environment mapping according to the direction of the reflected ray. At the intersection of cubes, the brightness value at the intersection is added to the brightness of the surface of the object to be tracked as a reflection component, which improves the efficiency of ray tracing and is suitable for real-time display of dynamic scenes. The environment mapping is only relative to a fixed point, and the cube is usually built in the center of the object. When the virtual object is small and the incident point is near the center point, a more accurate reflection result can be obtained; when the virtual object is large and the incident point is far away from the center point, the error will increase accordingly [11]; in addition, the closer the object in the scene is to the mirror, the more obvious the distortion will be obviously.

In the fast transformation algorithm of environment mapping, assuming that the incident point of light on the surface of the scene object is o, the environment mapping cube A is established with point o as the center, each surface of A

is parallel to the corresponding coordinate plane in the scene coordinate system, and six cameras with 90 ° opening angle are established by taking the direction perpendicular to a certain surface of the cube as the line of sight. The six images obtained by these six cameras are the projections of the surrounding scene on the surface of the cube, and they constitute the environmental mapping of the point. In the transformation of environment mapping, relative to the camera coordinates, moving the location of point o in the center of the cube, the orientation of the cube has no transformation. Therefore, the environment mapping cube with S at the original position is B, the cube surface with o at the intersection of reflected light is p, and the cube surface with S at $p1$. With o as the starting point, the projection of the false point k on the environment mapping A on op ray is p. When k takes different values, the change trajectory on the environment mapping B surface is the intersection of plane osp and B, and the upper bound of k is os and B. At this time, the upper bound of k is the pixel where the intersection of os and B is, and the lower bound is the pixel where the intersection of the line parallel to point s and op and B is. At this time, k is located in the interval abc between the upper and lower bound pixels where the trajectory line is located. That is to say, we need to find the brightness and depth information of the visible points in the direction of light reflected by the incident points on the original environment mapping cube, so as to improve the speed of intersection.

Next, we should judge whether the projection of k on the environment mapping cube A falls on the pixel p. It only needs to judge whether the angle between k and p is less than a certain threshold. The calculation of the threshold can refer to the following figure. p is the center of the pixel, u_0, u_1, u_1 and u_3 are four corners respectively. Point o is connected with any corner of p to get the cross product of the unit vector of the line and that of op, that is the threshold.

The direction vector of $\overset{\vee}{op}$ is:

$$\overset{\vee}{u}_1 = \begin{bmatrix} x_2 - x_3 \\ y_2 - y_3 \\ z_2 - z_3 \end{bmatrix} \quad (1)$$

$\overset{\vee}{u}_2$ is made unitization. It is noted that when testing all the pixels visible points in section abc on B, $\overset{\vee}{u}_1$ can only be calculated once. The direction vector of $\overset{\vee}{ok}$ is:

$$\vec{u}_2 = \begin{bmatrix} x_1 - x_3 \\ y_1 - y_3 \\ z_1 - z_3 \end{bmatrix} \quad (2)$$

$\vec{u}_2$ is made unitization. Then, the cross product $|\vec{u}_1 \times \vec{u}_2|$ of $\vec{u}_1$ and $\vec{u}_2$ is calculated. If the cross product is less than the threshold ε, the projection of k on the environment mapping cube A is considered to fall on the pixel p.

The speed of the improved acceleration algorithm is completely independent of the complexity of the scene and only related to the resolution of the environment mapping when solving the specular reflection component of the surface brightness of the object in the scene [12-14]. In addition, the depth information of the visible points is added to the environment mapping, which greatly facilitates the accurate calculation of the reflection and refraction components. Although this algorithm has not yet reached the speed of real-time processing, it provides a powerful way to generate reflection and refraction effects in real time because it has nothing to do with the complexity of the scene.

2.2 Establishment of optimization model

Based on the ray tracing rendering results of 3D visual interface, the optimization model of 3D interface interaction in digital media is constructed with the objective function of optimizing the visual attention distribution of the final layout of man-machine interface in digital media.

Firstly, the model is defined as follows:

(1) The visual attention level of the unit occupied by the target in different levels of visual field area is $Q = \{q_{ij}\}$, and q_{ij} is the visual attention level of the unit occupied by the target i in the visual field area j.

(2) The visual attention level of the target center in the field of vision is $E = \{e_{ij}\}$, e_{ij} represents the visual attention level of the centroid of the target i in the field of vision j.

(3) The number of units occupied by the target in different levels of vision area is $D = \{d_{ij}\}$, and d_{ij} is the number of units in the field of vision j of target i.

Where, $i = 1, 2, \ldots, n$, n is the number of target modules; $j = 1, 2, 3$, respectively, represents the field of vision area A, B and C. The importance of the target module is directly proportional to the visual attention level of the unit occupied by the target in the field of vision area of different levels, the field of vision area occupied by the target centroid, and the number of units occupied by the target in different field of vision area [15,16], that is, for digital media software, the more important target should have a certain area and be as close to the visual center as possible.

The intensity of visual attention distribution Z is defined as:

$$Z = \sum_{i=1}^{n}\sum_{j=1}^{3}\omega_i q_{ij} e_i d_{ij} \quad (3)$$

Let $Y = \max Z$, then

$$Y = \max\sum_{i=1}^{n}\sum_{j=1}^{3}\omega_i q_{ij} e_i d_{ij} \quad (4)$$

In equation 4:

$$d_{ij} = \sum_{j=1}^{3} d_{ij} \quad (5)$$

The optimization objective function is as follows:

$$S = \sum_{i=1}^{n}\sum_{j=1}^{3} d_{ij} \quad (6)$$

Equation (5) indicates that the number of units occupied by target i in the field of vision of different levels is equal to the number of units occupied by target i in the field of vision; equation (6) indicates that the number of units occupied by all targets in the field of vision of different levels is equal to the area of all targets in the field of vision. The larger the Z value is, the more important the user's visual attention is allocated to the target module.

2.3 Model solving

2.3.1 Feature selection of genetic algorithm

The layout of 3D interactive interface in digital media should fully consider the coordination among human, machine and environment. The user is human, and the comfort of interface layout depends on the physiological and psychological factors of human in the environment. Physiological factors are mainly considered when people are placed in the three-dimensional space environment. As the main body of the space, people use the limited space to maximize their work needs. At the same time, they must consider the physiological comfort of people in the environment [17], such as the size of the human body, the health of the working posture, the rationality of the angle of each joint, the accessibility and convenience of human hands, and the law of visual field. Psychological factors mainly focus on the problems that should be considered in the layout of two-dimensional plane, the reaction of people to the color in the layout, and the recognition of shape need to achieve ease of use, reduce the error rate and injury.

Man-machine constraints are added to the genetic algorithm to solve the model optimization problem. The man-machine constraints include three-dimensional finger accessible area, visual field, and two-dimensional icon color and shape. Three-dimensional can be regarded as the hardware interface in the mobile terminal interface design, while two-dimensional is the software interface. The core of using genetic algorithm to solve the interface layout problem is not to maximize the interface, but a more reasonable elimination and selection mechanism. Inspired by Darwin’s theory of evolution and the mechanism of genetics, it belongs to evolutionary computing. Starting from a set representing the possible characteristics of the problem, the genes are cross mutated. In this process, the high-quality individuals of the target problem are retained, and the low-quality individuals in the genetic process of the offspring are eliminated. How to keep the interaction path optimal in the derivation process of mobile terminal layout needs to consider the man-machine constraints in the initial set feature selection, so as to ensure that the genetic process falls into local maximization rather than optimization. That is to say, the feature of man-machine constraint [18] is regarded as a dominant chromosome in its genetic process. If the offspring is lost, repeated calculation will be carried out. In the target of the interface to be deployed, the man-machine constraint feature gene is encoded. If the actual gene is encoded, it contains a large number of individuals and the work is complex. Binary code can be used, the length of the code is the number of man-machine constraints, each corresponding to a feature. 1 means that the constraint feature is selected, and 0 means that there is no constraint feature. In the algorithm, each code corresponds to a solution. Generally, the adaptability function is used to measure the advantages and disadvantages of the solution. A mapping is formed from the fitness of a genome to its solution. Therefore, the optimal solution can be obtained in the multivariate function. The purpose is to negate the gene that does not carry man-machine constraint characteristics in the genetic process.

According to the adaptive function $F(x)$, the individuals of each generation are guaranteed to ensure the constraint conditions in the evolution process. The normal individuals that meet the constraint are recorded in F_i, and the probability P_i of normal individual i being selected is calculated.

$$P_i = \frac{F_i^{-1}}{\sum_{i=1}^{m} F_i^{-1}} \quad (7)$$

The cumulative probability is as follows:

$$P_k = \sum_{i=1}^{k} P_i \quad (8)$$

In the above equation, $i = 1, 2, \ldots, m$, $k = 1, 2, \ldots, m$.

Assuming that the number of initial interface icons to be optimized is 100, the bi-directional crossover probability is 1.6, the mutation rate is 0.1, and the algorithm stops evolving 600 times, the optimal feature subset and adaptability will not change within 100 times, so the less the number of features is, the better it is.

2.3.2 Particle swarm optimization algorithm

Particle swarm optimization is used to optimize the genetic algorithm to avoid the genetic algorithm falling into local optimal solution. Particle swarm optimization algorithm is suitable for the space with unclear search scope, in which each particle represents a potential solution with the optimal visual attention allocation intensity Z [19,20]. The inertia weight ω_i is introduced into the basic particle swarm optimization algorithm, which can not only maintain the global search ability of particle swarm optimization, but also effectively enhance the local search ability of particle swarm optimization. At present, there are three methods to determine the inertia weight: fixed weight method, random weight method and linear decreasing weight method. Compared with the other two methods, the linear decreasing weight method has the advantage of reflecting the change of inertia weight with the number of iterations more flexibly. The expression is as follows:

$$\omega(t) = \omega_{\max} - \frac{\omega_{\max} - \omega_{\min}}{T_{\max}} \times t \quad (9)$$

In equation (9), $T_{\max}$ and t are the maximum number of iterations and the current number of iterations, respectively.

3. Experimental analysis

3.1 Experimental environment

This paper selects an information digital media software as the experimental object, and takes the layout optimization design of the man-machine interface of the software as an example. The target modularization and numbering are carried out for the front page interface of the software, and the modularization results are shown in Figure 1.

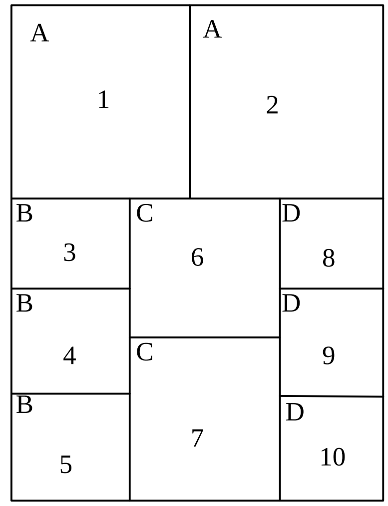


Figure 1 The target modularization result of the man-machine interface

Before optimization, the unit number of each module in different areas is shown in Table 1.

Table 1 The number of units of each module in different areas before optimization

Area	Module serial number	Number of units/N
A	1	8
	2	6
B	3	11
	4	35
	5	42
C	6	15
	7	9
D	8	32
	9	17
	10	18
Total		193

3.2 Result analysis

Ten scenes in the digital media software are established by the proposed method. The number of scene images, patches and light sources are shown in Table 2.

Table 2 Scenario establishment results

Scene serial number	Scene/N	Number of wraps/N	Number of light sources/N
1	7	65484112	1
2	6	59451362	2
3	11	213594541	2
4	12	221547984	1
5	15	256485642	3
6	8	84651211	2
7	10	198546123	1
8	5	39546152	2
9	4	15367841	1
10	23	385461521	2

Different methods are used to optimize the 3D interactive interface of digital media software, and the comparison results of required times are shown in Figure 2.

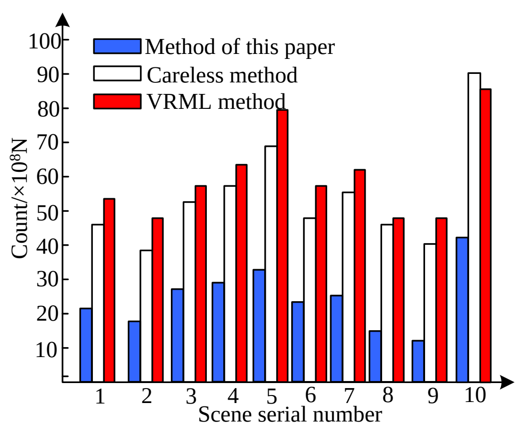


Figure 2 Comparison of the number of intersections

As can be seen from the experimental results in Table 2 and Figure 2, the more complex the scene structure is, the more triangular patches constituting the scene are, and the smaller the patches are. The proposed method can greatly reduce the number of invalid intersection between the light and the patches in the bounding box. This method has great advantages in scene establishment, and provides a good foundation for subsequent 3D interface interaction optimization.

The proposed method is used to optimize the 3D interactive interface of the digital media software. The results of unit number of each module in different areas after optimization are shown in Table 3.

Table 3 The number of units of each module in different areas after optimization

Area	Module serial number	Number of units/N
A	1	9
	2	9
B	3	13
	4	30
	5	38
C	6	12
	7	21
D	8	28
	9	16
	10	17
	Total	193

To achieve the optimal level of man-machine interface layout, we should not only maximize the intensity of visual attention distribution, but also consider the limitations of the target in space and whether the layout is in line with people's basic aesthetic. Combined with the experimental data in Table 3, it can be seen that the proposed method places the relatively important modules and modules in the conspicuous area of the field of vision, which is conducive to the operation of the practical application of the software, the most important target module is arranged in the center of the interface, and other target modules are symmetrically distributed with it as the center, which is in line with the basic aesthetic of human.

The time-consuming of scene establishment, scene rendering, feature selection, interface optimization, icon recognition and icon memory of digital media software optimized by three methods are counted. The comparison results are shown in Figure 3.

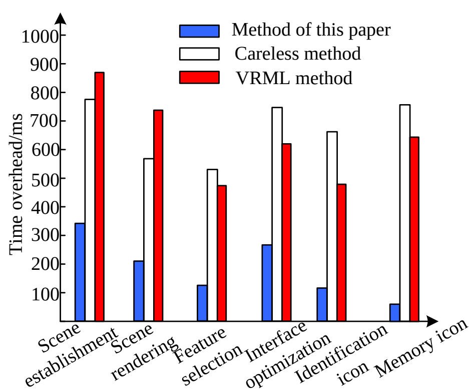


Figure 3 Comparison of time cost

As can be seen from the experimental results in Figure 3, the time-consuming of the method in this paper to optimize the 3D interactive interface of digital media software is significantly lower than that of the other two methods. The time-consuming of recognizing and memorizing icons by using the proposed method to optimize the 3D interactive interface of digital media software is lower than that of the other two methods. The comparison results show that the proposed method has lower time cost, which effectively verifies that the proposed method has higher optimization performance.

100 users (10 expert users, the rest are new users) are selected as the test objects. Eye movement experiments are used to optimize the three-dimensional interface interaction performance of digital media software. The experimental design process is as follows:

(1) Purpose of the experiment

Through the optimization design of 3D simulation visual interface effect of mechanical motion and the video image after optimization design, the eye movement characteristics are recorded by eye tracker, and the eye movement experimental data table is analyzed to judge the influence of visual interface optimization elements on the subjects in different degrees.

(2) Experimental methods

Eyelink Ⅱ eye movement instrument is used, which is composed of two Petium 4 terminals connected by Ethernet. One of them displays the experimental materials, the other records the eye movement data. The experimental pictures are displayed on a 22.5-Inch flat panel display with a refresh rate of 86Hz, a resolution of 1024 × 768 pixels, and a sampling frequency of 500Hz.

(3) Experimental process

In the first step, after entering the experimental area, the subjects sat 1 meter in front of the instrument and wore an eye tracker;

The second step is to use the head mirror correction to ensure that the subject's face is parallel to the screen, that is, the line of sight is vertical to the center of the screen, and then after further glasses correction, the subject's line of sight is one-to-one corresponding to the screen coordinates, that is, the coordinate points seen are the recorded coordinate points; the third step is the guiding language: please carefully watch the image on the screen, and select the image with better visual effect.

(4) Experimental results

The data analysis package of eye tracker is used to collect and record the eye movement data.

The eye movement experiment results of three methods to optimize the 3D interactive interface of digital media software are shown in Figure 4.

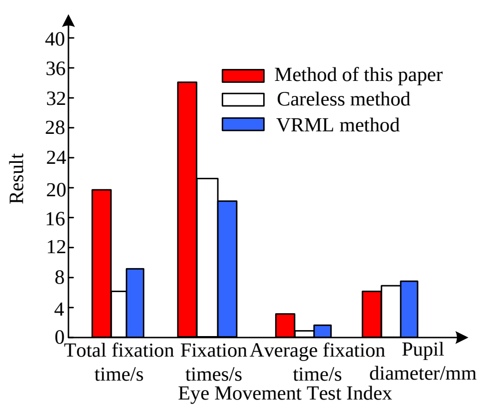


Figure 4 Test results of eye movement experiment

Total fixation time refers to the sum of all fixation time for an image. Saccade refers to the continuous movement of the eyeball when people watch the image. The relative static state of the eyeball between the two saccades is fixation. Fixation times refer to the number of fixation points. The size of pupil is affected by physical factors such as light intensity, mental state, emotion and cognitive load. The heavier the mental load is, the larger the pupil is. From the results of eye movement experiment data, we can see that the longer the total fixation time is and the more the fixation times are, the more it is attractive; the larger the pupil diameter is, the worse the image quality is and the harder it looks.Therefore, the subjects pay more attention to the interface image after optimization design, and the image quality is better than that before optimization design. The evaluators are experts and ordinary users. Expert users, commonly known as "experts", are experienced in the field, familiar with relevant knowledge and methods, and can make strict and clear judgments on the quality of video effects; ordinary users refer to "laymen" who have not received professional knowledge training, and viewers who do not understand, have not contacted or have no experience. As can be seen from the experimental results in Figure 4, the total fixation time, fixation times and average fixation time of the three-dimensional interface optimized by the method in this paper are significantly higher than those of the other two methods, and the pupil diameter of the three-dimensional interface optimized by the proposed method is lower than that of the other two methods. The comparison results show that the proposed method is effective in optimizing the 3D interactive interface of digital media, and can enhance the user's interest in the software interface.

Under the specified viewing conditions, let the evaluators watch the image sequences of software display interface obtained by different optimization methods, and grade the interface image effect. The comparison results of interface image scoring are shown in Figure 5.

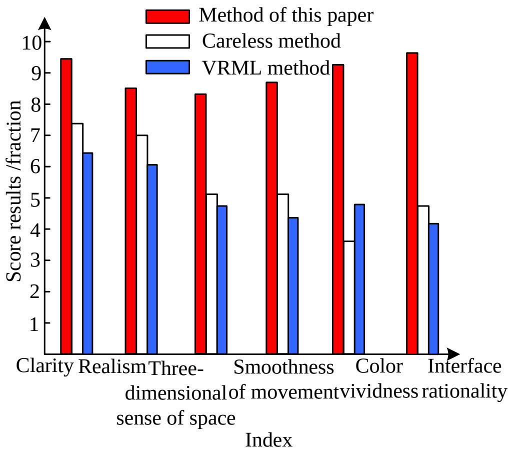


Figure 5 Comparison of subjective effects of interface images

As can be seen from the experimental results in Figure 5, the subjective evaluation results such as interface clarity and realism of the method in this paper are better than those of the other two methods. The experimental results verify the effectiveness of the method in this paper.

The 10-point system is selected as the scoring standard, and the visual attention method and VRML method are selected as the comparison method. The user can evaluate the interactivity of the digital media software using the three methods to implement the three-dimensional interface interaction optimization. The interactive evaluation results are shown in Figure 6.

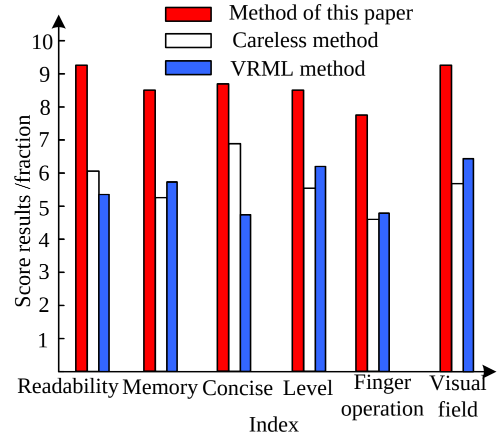
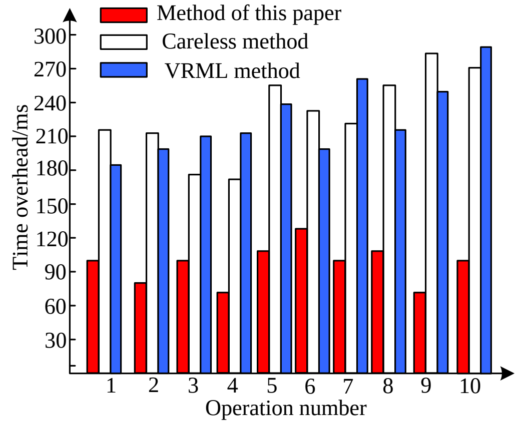


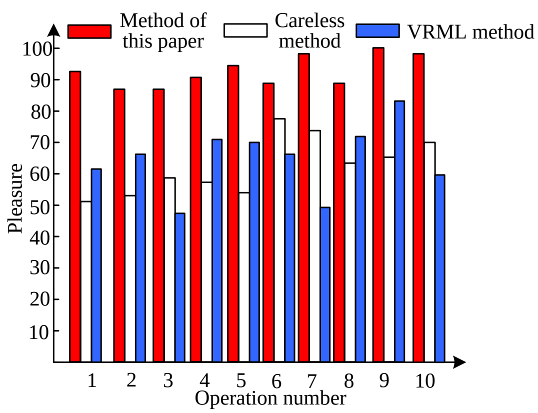
Figure 6 Comparison of interactive evaluation results

As can be seen from the test results in Figure 6, the user's satisfaction with the readability, memory, simplicity, hierarchy, finger operation and visual field of the 3D interface optimized by the method in this paper is higher than that of the other two methods, which effectively verifies that this method has high performance of 3D interface interaction optimization and can obtain user's satisfactory results.

The operation time cost and pleasure degree of the three methods under different operation times are counted, and the comparison results are shown in Figure 7.



(a) Time overhead



(b) Pleasure

Figure 7 Comparison of operation results

The experimental results in Figure 7 show that under different operation times, the time cost and pleasure degree of the user operating the software are significantly better than the other two methods, indicating that the method in this paper can operate the software quickly in a short time, and the pleasure degree of the user using the software is higher. Based on the above experimental results, the method in this paper is used to optimize the 3D interactive interface of digital media software. The visual effect of the interface is superior, and the interactivity can meet the needs of users. It is verified that this method has high optimization performance.

4. Conclusion

The development of digital media has created an integrated and interactive digital virtual space for us. The interactive way has formed the influence on the creative performance and development of digital media from multiple levels. With the rapid development of virtual reality technology and its application in digital media in recent years, the creative performance of digital media is presented in a more natural way, and the communication between people is more emotional and personalized, which improves the appeal and expressiveness of virtual reality environment. This paper studies the optimization of 3D interface interaction in digital media, fully considers the visual attention allocation of the final layout of man-machine interface in digital media, completes the optimization of 3D interface interaction, and verifies the effectiveness of the proposed method through experiments. With the development of digital media, interaction design provides users with a new experience. At the same time, it expands the interaction space and innovates the interaction mode. In the future, it is necessary to study the related fields of interaction design application, especially the users. Only by optimizing the design of interaction products from the perspective of users, can a more suitable and convenient man-machine interaction mode be developed.

Reference

1. Zhu X.P., Xu H.Y., Wan J., Airport fire emergency rescue virtual drill platform based on virtual reality technique, Computer Simulation, 2020, 37(02), 107-110.
2. Ng N., Javadian F., Tse S., Jiang A.,Doroudi M., Reimagining dissection lab preparation the role of digital media in anatomy education, The FASEB Journal, 2020, 34(S1), 1-1.
3. Feng F., Akkutlu I.Y., A simple molecular kerogen pore-network model for transport simulation in condensed phase digital source-rock physics, Transport in Porous Media, 2019, 126(2), 295-315.
4. Saxena N., Alpak F.O., Hows A., Freeman J., Hofmann R.,Appel M., Estimating fluid saturations from capillary pressure and relative permeability simulations using digital rock, Transport in Porous Media, 2021, 136(3), 863-878.
5. Spencer R., Alexander V., Eickhoff J., Woo K., Rose S., A digital media attention diversion improves mood and fear in patients receiving chemotherapy for recurrent gynecologic malignancies: results of a randomized trial, International Journal of Gynecological Cancer, 2020, 30(4), 1185-1192.
6. Chen G.Q., Huang X., Zhang A.M., Wang S.P., Simulation of three-dimensional bubble formation and interaction using the high-density-ratio lattice boltzmann method, Physics of Fluids, 2019, 31(2), 271-275.
7. Zaehringer E., Schwabe M., Zhdanov S., Mohr D.P., Knapek C.A., Huber P., et al., Interaction of a supersonic particle with a three-dimensional complex plasma, Physics of Plasmas, 2018, 25(3), 33-36.
8. Fotue A.J., Diffo T.V., Baloitcha E., Mbognou F.C.F., Tedondje G.T.,Hounkonnou M.N., Spin-orbit interaction on the thermodynamics of three-dimensional impurity magnetopolaron under strong parabolic potential, The European Physical Journal Plus, 2020, 135(5), 1-14.
9. Wang Y., Kim J.C., Wu R.J., Martinez J., Song X., Yang J., et al., Van der waals contacts between three-dimensional metals and two-dimensional semiconductors, Nature, 2019, 568(7750), 70-74.
10. Huang J.,Teng B., The second-order interaction of monochromatic waves with three-dimensional bodies in a channel, Ocean Engineering, 2020, 217(2), 1079-1082.
11. Zhao K., Stead D., Kang H., Gao F., Donati D., Three-dimensional numerical investigation of the interaction between multiple hydraulic fractures in horizontal wells, Engineering Fracture Mechanics, 2021, 246(2), 107-111.
12. Zhang Y., Wu Y., Wang G., Wang W.,Ding P., The enhanced coulomb interaction in three-dimensional indium tin oxide films, Journal of Applied Physics, 2020, 128(12), 1251-1255.
13. Yoshida N., YamaguchiT., Development of a solvent-polarizable three-dimensional reference interaction-site model theory, The Journal of Chemical Physics, 2020, 152(11), 114-119.
14. Chen Z., Huang P.,Zhang Z., Interaction between carbon dioxide emissions and eutrophication in a drinking water reservoir: A three-dimensional ecological modeling approach, Science of The Total Environment, 2019, 663(01), 369-379.
15. Feng Y.L., Guo S., Jacob J., SagautP., Grid refinement in the three-dimensional hybrid recursive regularized lattice boltzmann method for compressible aerodynamics, Physical Review E, 2020, 101(6), 633-637.
16. Wang P., Zhao M., Li H.,Du X., An accurate

and efficient time-domain model for simulating water-cylinder dynamic interaction during earthquakes, Engineering Structures, 2018, 166(01), 263-273.

17. Duan W., Gao Y., Yu Q., Wu T.,Wang Z., Numerical simulation of coal gasification in molten slag: gas-liquid interaction characteristic, Energy, 2019, 183(15), 1233-1243.
18. Zhang W., Wang X., Du L.,Sun X., Mutual effect between swept-and-leaned vanes and acoustic liners on fan interaction-noise reduction, Aiaa Journal, 2019, 57(6), 2479-2488.
19. Ishaq M., Xu H.,Sun Q., Interactions of multiple three-dimensional nonlinear high frequency magnetosonic waves in magnetized plasma, Physics of Fluids, 2020, 32(7), 77-80.
20. Guo H.D., Xia T.C.,Ma W.X., Localized waves and interaction solutions to an extended (3+1)-dimensional kadomtsev-petviashvili equation, Modern Physics Letters B, 2020, 34(6), 205-201.

Yiping Zhang, male, born in November 1978, Associate Professor. He graduated from Shanghai Jiaotong University in 2000, majoring Industrial Design B.A. He studied at DFI College of Communication Art and New Media in Hamburg, Germany, majoring Communication Design, and was awarded M.A. degree of Design in Digital Media at University of Portsmouth. Now he is working in Zhejiang Wanli University at Sino-German Institute of Design and Communication. His research areas include digital media design, technology in digital interaction, user interface and user experiences. He has published 8 academic papers in above area. He has hosted and participated 9 research projects, and organized 4 international symposiums and conferences.

KoljaWilker, male, born in December 1974, Programmer, Senior Lecturer. He graduated from DFI College of Communication Art and New Media in Hamburg, Germany, majoring Communication Design, and was awarded M.A. degree of Media Innovation from Brand University of Applied Sciences, Germany. Now he is working in Zalando STUPS and Beijing Normal University. His research areas include Algorithm and Data Structure Optimization, Digital Media Design. He has published 3 academic papers in above area. He participated 7 international symposiums and held over

10 lectures in Europe and China.

Jan Kurzinger, male, born in April 1976, Senior Lecturer, Interactive Designer. He graduated from DFI College of Communication Art and New Media in Hamburg, Germany, majoring Communication Design, and was awarded M.A. degree of Interaction Design at Bucks New University. Now he is working in JMK Motion Design and DFI College of Communication Art and New Media. His research areas include DigitalMotionDesign,User Interface and User Experience Design. He has participated 6 applied research projects in above areas, and held over 8 lectures in Europe and China.