Visual Communication Design Based on the Internet of Things

Leilei Yang[1] and Yi Zhang[2]

[1]Institute of Art & Design, Shaanxi Fashion Engineering University, Xi'an, Shannxi 712000, China, yll342119370@163.com
[2]School of Fine Arts, Zhengzhou University, Zhengzhou, Henan 450000, China, zz1991zy@zzu.edu.cn

Corresponding author: Yi Zhang, zz1991zy@zzu.edu.cn

Abstract. In modern information society, the increasingly profound digital revolution makes IoT application gradually become a high-speed and mature modern information dissemination method. IoT visual design makes information rely on electronic carriers to become visual elements with aesthetic and humanized characteristics through aesthetic expression and efficient dissemination of information. On this basis, this paper studies the visual communication design method based on IoT technology to enhance the visual communication design effect of web interface. In this paper, the role played by IoT technology in the corresponding design aspects is firstly established, and the design trends are proposed for the information communication mode and information reception mode in the web interface design. Second, the graphical expression of visual information elements of IoT technology is analyzed and the techniques and means of web design performance are summarized. Finally, the visual communication design of web media is compared with other art design forms, and the research data is processed with WEB2.0 to give design guidance from both qualitative and quantitative perspectives. The experimental results show that the perfect combination of visual aesthetics and communication function based on IoT becomes the ultimate goal of creative thinking activity of IoT design.

Keywords: Internet of Things; Visual Communication; Modern Design
DOI: https://doi.org/10.14733/cadaps.2023.S11.201-211

1 INTRODUCTION

With the unprecedented prosperity of visual expression, the field of visual communication design research is no longer limited to art, but has expanded to a broader range of high technology, especially the Internet of Things technology. Blas and Gonnet [1] use model driven engineering to construct simulation models specifically, improving the interaction between abstraction and specificity in advancing modeling and simulation theory and practice. The process is described in detail as a domain model. Colla et al. [2] Only by integrating user generated content and a hybrid strategy of automated technology can this bottleneck be overcome. The PRiSMHA project has contributed to this direction in designing and developing prototypes for ontology driven platforms, which support user generated semantic metadata. The digital development has promoted the mass production of graphics, and through the Internet of Things (IoT), visual information can be disseminated at high speed, shortening the distance between people in time and space, and the IoT has formed a communication network of virtual and real links between various media. However, following the aesthetic principles and creative thinking methods of traditional visual communication design art can no longer meet the stylized visual effects. Many advances have been made. Lee et al. [3] introduced data preprocessing methods, which clean up raw data to achieve consistency and repeatability in the application. We introduced the applicability of big data and artificial intelligence methods in the field of drug design. Therefore, in order to better explore the aesthetic rules and expressions of new media design art through design experiments and practices, the visual communication language needs to be expressed in a new form of information media in the video interface mediated by digital terminals.

The first chapter introduces the background of the research of this paper. It introduces and WEB2.0 web-related technology, and proposes the topic of this paper based on the core content of visual communication design and elaborates the research content of the topic. Chapter 2, introduces the graphic rendering pipeline of visual communication design, analyzes and discusses the analysis of visual composition elements in web pages, and describes the current status of domestic and international research and development trend of virtual reality technology. Chapter 3, analyzes and introduces the design of modern visual communication digital systems, in which the representation of 3D objects and several methodological techniques used for solid object modeling are described and studied, and visual communication design and production ideas and methods are introduced in detail with the Internet of Things environment. Chapter 4, which focuses on the concrete implementation of visual communication design graphics, details the construction and rendering of the scene. At the same time, we test the simulation and discuss the performance optimization scheme according to the design effect, release the application, and combine with IoT can view the display effect. The research results show that this paper achieves an immersive visual experience and tangible visual communication by designing a web interface visual communication design effect system and combining it with the developed IoT scenes.

By applying the rules of artistic form and beauty to the composition elements of web pages, we can create a visual environment that meets the design purpose, highlight the theme, enhance the viewer's attention to the web pages, and improve the understanding of the contents of the web pages. Only when the two aspects are organically unified can the best effect of the theme be achieved.

2 STATE OF THE ART

Visual communication design in the context of the Internet of Things (IoT) inevitably has to go through the stage of inheritance and imitation of IoT-based visual communication design forms before developing its own unique form. Liu et al. [4] conducted a better data collection platform verification, and this platform conducted a more centralized and excellent data validation. Ma ć Kowski et al. [5] utilized digital technology to convert multimedia resources into digital formats. For example, images, audio, videos, etc. for easier storage and transmission. Through virtual reality technology, multimedia resources can be reproduced, such as converting them into virtual environments, in order to simulate multimedia scenes more realistically. Through augmented reality technology, multimedia resources can be enhanced, such as converting them into augmented reality models, in order to simulate multimedia scenes more realistically. Pando et al. [6] achieved intelligent control of multimedia resources through intelligent control technology, such as converting multimedia resources into virtual games, in order to experience multimedia more interestingly. It was found that through multimedia integration technology, multimedia resources can be integrated, such as converting them into digital cinemas, in order to view multimedia resources more conveniently. Reyes and Sonesson [7] use computer-aided interaction to refer to the use of computer technology to improve human-computer interaction, in order to improve user experience and efficiency. In the context of new media, visual communication technology and art are important directions in computer-aided interaction research. Visual communication technology includes multimedia forms such as images, videos, and audio, which play an important role in new media communication. Art can be used to express emotions, convey information, resonate, and so on. Wang [8] uses computer technology to improve human-computer interaction to improve user experience and efficiency. In new media scenarios, new media technology can improve user experience and efficiency by enhancing interactivity. For example, using virtual reality technology can reproduce multimedia resources to simulate multimedia scenes more realistically, thereby improving users' immersion and interactivity. By using big data analysis and machine learning techniques, personalized recommendations can be made, recommending relevant multimedia resources based on users' interests and behavioral habits, thereby improving user satisfaction and stickiness. Control and provide feedback based on user intentions and actions to improve user experience and efficiency. Zhang [9] uses artificial intelligence technology and machine learning technology to achieve adaptive design, making corresponding designs and adjustments based on user habits and needs, thereby improving user experience and efficiency. The computer-aided interaction research of visual communication technology and art can improve user experience and efficiency by enhancing interactivity, personalized recommendations, intelligent control, and adaptive design, thereby promoting the development of the new media industry. Ziatdinov and Valles [10] studied the field of visual communication technology and art related to mathematics. For example, image processing, video encoding and decoding, audio processing, etc. Image processing is an important issue in visual communication technology and art, involving the collection, storage, editing, and decoration of images. For example, image edge detection, image deformation, image filtering, image compression, etc. Video encoding and decoding is another important issue in visual communication technology and art, involving aspects such as video compression, decompression, and format conversion. For example, video encoding and decoding standards such as H.264/MPEG-4 AVC and HEVC. The mathematical problems in visual communication technology and art involve fields such as image processing, video encoding and decoding, and audio processing, which require the application of knowledge in mathematics such as graph theory, signal processing, and digital signal processing.

3 MODERN VISUAL COMMUNICATION DIGITAL SYSTEM DESIGN

3.1 The Overall Framework

In this paper, the system is designed with a central control structure system, model display and user interaction operations are realized through the user layer, shared objects are set on the server, modeling is provided by the server, shared models are completed, and collaborative members obtain results through broadcasting. The overall framework of the system is shown in Figure 1.

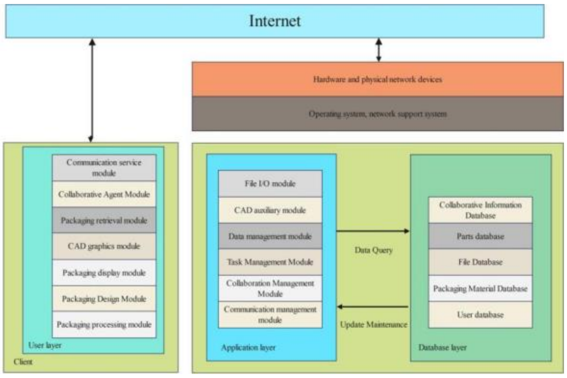

Figure 1: Overall system framework.

In this paper system, the user layer is mainly responsible for interactive operations, and the communication service module is responsible for transferring information between the server and the client.

The communication module in the service layer realizes the connection and data interaction; the publishing module is responsible for releasing the dynamic information of the system online; the responsible for user registration information and realizing identity verification, and also responsible for authority management. Each module in the database layer is responsible for storing data information parameters, etc.

3.2 Visual Communication Implementation

The working process of the multimedia visualization module in the visual communication digital system is shown in Figure 2.

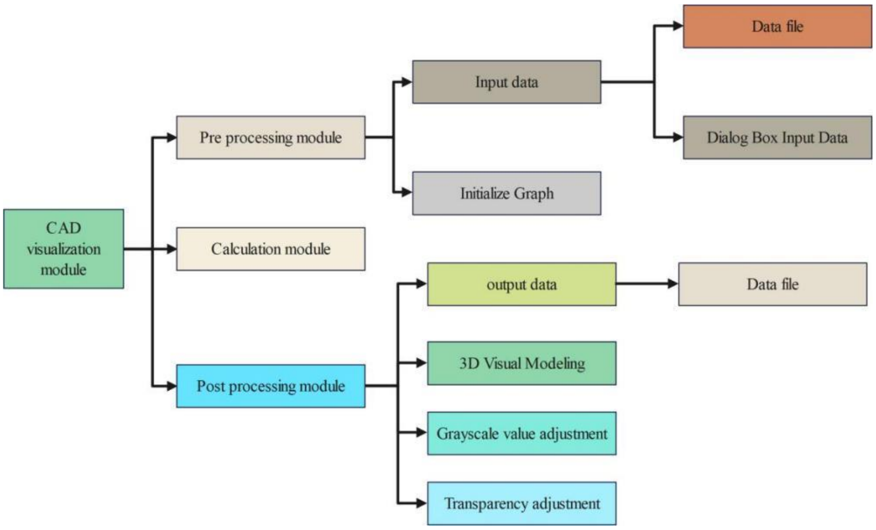

Figure 2: Working process of multimedia visualization module.

Combine digitalization and human-computer interaction to collect the geometric information of packaging materials and parts. Firstly, the coordinates of the edge corner points of each packaging material are collected, the vertices and bottom points are confirmed, the adjacent vertices and bottom points are connected to form the sides of the packaging material, the vertices and bottom points are confirmed in order to form the top and bottom surfaces, and the points, lines and surfaces are connected to construct the geometric model of the whole packaging material and parts. On this basis, the texture features of the packaging material and parts are extracted by contributing equations to:

$$A = A_0 - k\frac{\lambda_1(a-a_r)+\theta_1(b-b_r)+\varphi_1(c-c_r)}{\lambda_3(a-a_r)+\theta_3(b-b_r)+\varphi_3(c-c_r)} \tag{1}$$

$$B = B_0 - k\frac{\lambda_2(a-a_r)+\theta_2(b-b_r)+\varphi_2(c-c_r)}{\lambda_3(a-a_r)+\theta_3(b-b_r)+\varphi_3(c-c_r)} \tag{2}$$

Where: A and B both represent the point plane coordinates of packaging materials and parts; ar, br and cr represent the spatial coordinates of packaging materials and parts; A0, B0 and k represent the inner azimuthal elements of packaging materials and parts; λi, θi and φi (i=1, 2, 3) represent the direction cosine composed of outer azimuthal elements of packaging materials and parts. The texture information of packaging materials and parts is extracted according to the criterion of optimal judgment of coordinate acquisition. Considering that the product packaging is usually attached to the plane and stationary, its texture features are obtained using orthomosaic images, and a digital surface model is obtained using infrared measurements, which is combined with orthomosaic images to construct a 3D visual model. After completing the modeling, the HO visualization algorithm is used for this model in the CAD drawing process to adjust the transparency and grayscale values of the product packaging.

3.3 Graphic Display Size and Position Calculation

In computer graphics, the coordinate system is usually Cartesian coordinate system or polar coordinate system. The Cartesian coordinate system represents points and lines in space as a set of numerical values, while the polar coordinate system represents points and circles in space as a set of numerical values. Distance and angle are basic metrics that describe the relationship between objects. In computer graphics, common distance measurement methods include Euclid distance, Manhattan distance, cosine distance, etc. The commonly used methods of angle measurement include radian system, angle system, and conversion between angle systems. Coordinate transformation is the process of transforming coordinates in one coordinate system into coordinates in another coordinate system. In computer graphics, common coordinate transformation methods include translation, rotation, scaling, etc. In summary, the mathematical knowledge involved in graphic display and position calculation includes coordinate systems, distances and angles, circles and arcs, coordinate transformations, curves and surfaces, etc. In practical applications, it is necessary to choose appropriate measurement methods and algorithms based on specific situations to ensure the accuracy and efficiency of calculations. The layout objective function can be described as:

$$\min = (m-1)Y + h \tag{3}$$

$$G = (Q, AG, GG) \tag{4}$$

$$AG = \{s \mid s(q_1, q_2, n); q_1 \in Q, q_2 \in Q\} \tag{5}$$

In Eq. (5) s is used to describe the connection relations between graph elements, including two kinds of connection relations, Cfrom and Cto. Cfrom is used to describe the connection from q2 to q1, q1 represents the present stage graph element, Cto is used to describe the connection from q1 to q2; n is a natural number to describe the multiplicity of connections.

$$CG = \{(q, render, layout) \mid p \in P\} \tag{6}$$

In equation (6), R is used to describe the set of graphical appearance types; L is used to describe the set of graphical position relations; render is used to describe the correlation between graphical elements; layout is used to describe the different graphical classes; P is used to describe the graphical symbol system.ASM belongs to dynamic algebra, and the algebra can be defined on some alphabet Σ with the expression:

$$\sum = \{ f_1^0, f_2^0, \cdots, f_{kL}^0, f_L^1, f_{kv}^\pi \} \tag{7}$$

In formula (7): f0 is used to describe the m-element function symbols, the function symbols include static and dynamic, the 0-element static function symbols are called constants, and the 0-element dynamic function symbols are called program variables; the subscript kL indicates the state of the algebra, L indicates static constants, and kv indicates dynamic constants. It is assumed that all alphabets containing static constants are Boolean true values to facilitate the description of some functions.

3.4 User Evaluation Test

The intrinsic connection is described by W, and the amount of gaze and gaze time are described by BHxy and BCxy in turn,

$$BH_{xy} = W(V_1, V_2, V_3 \mid \Gamma_1, \Gamma_2) \tag{8}$$

$$BG_{xy} = W(V_4, V_5 \mid \Gamma_1, \Gamma_2) \tag{9}$$

Where: y=1, 2, and 3 represent multimedia combination, graphic use choreography, and text choreography in order; Γ1 and Γ2 denote control variables. The independent variable of the relationship function is the affiliation to a particular cognitive style in visual communication design, which is described by ωr, ωr ∈ (0, 1).

The user's attention to the visual area H and the user's cognitive style affiliation C are divided by the corresponding area adjustment coefficients ɑ, γ in turn to obtain the first adjustment values BH and BCy, and then BH and BC are divided by VH. and VC in turn, that is, to obtain the values of AH and AC, and the formula is described as follows:

$$\begin{cases} BH_{xy} = H_{xy} / \alpha_{xy} \\ BC_{xy} = C_{xy} / \alpha_{xy} \end{cases} \tag{10}$$

$$\begin{cases} AH_{xy} = BH_{xy} / VH_x \\ AC_{xy} = BC_{xy} / VC_x \end{cases} \tag{11}$$

Where: AHxy is used to describe the average gaze volume of each region; ACxy is used to describe the average gaze time of each region; VHx is used to describe the total gaze region; VCx is used to describe the total gaze time. In the case of x=0, AHxy and ACxy describe the minimum value of the average gaze volume and gaze time of each region in turn. In the case of x ≠ 0, the two variables average the amount and time of gaze in different layouts, and we have:

$$AH_{0y} = \left(\sum_{x=1}^{4} AH_{xy} \right) / g \tag{12}$$

$$AC_{0y} = \left(\sum_{x=1}^{4} AC_{xy} \right) / g \tag{13}$$

The satisfaction of the research subjects with the results of the automatic choreography of different algorithmic graphic languages in visual communication design can be derived from equation (14) :

$$S = \sum_{i=1}^{n} (n - i + 1) S_i \tag{14}$$

The evaluation results are divided into four levels, A, B, C and D. A represents very satisfied, with scores between 8 and 10; B represents satisfied, with scores between 5 and 7; C represents more satisfied, with scores between 3 and 4; D represents unsatisfied, with scores between 0 and 2. Si represents the satisfaction coefficient, and the satisfaction coefficients of A, B, C and D are 1, 0.75, 0.35 and 0, respectively; n denotes the number of visual communication designs; and i denotes the counter. A super-domain is usually partitioned into several subdomains, and the partitioning of subdomains is usually described using a characteristic function. If f defines a domain when and only when

$$f(a) = undef \tag{15}$$

4 RESULT AND ANALYSIS

4.1 Experimental Verification

Experimental tests were conducted in an IntelP4.3G processor, 520M memory environment, requiring a layout size of 80×120 in visual communication design, The experiments were conducted to test the algorithm as a comparison, and the results are depicted in Figure 3.

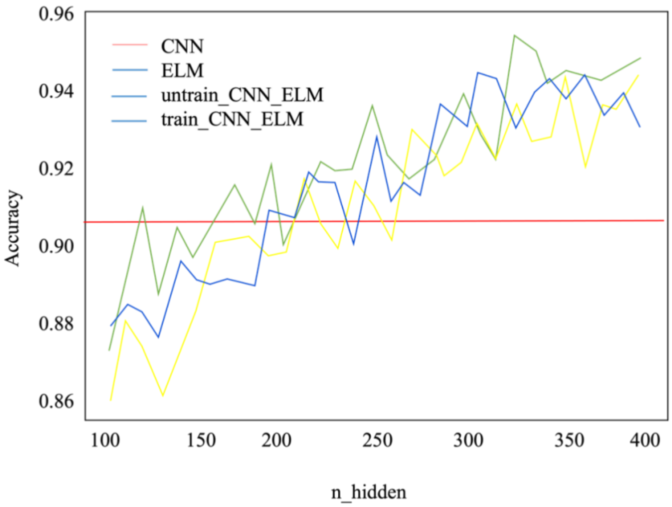

Figure 3: Graphical language layout results of the proposed algorithm.

Using this system to design the packaging of the experimental object, its packaging design effect conveys many visual symbols from multiple angles of color, font, transparency and clarity, with sharp color contrast, font and layout design with characteristics, producing a strong visual impact and good visual communication effect. The comparison results are shown in Figure 4.

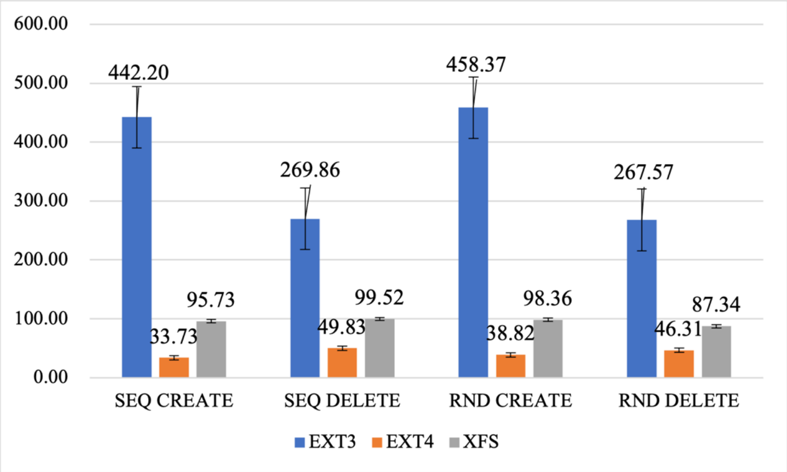

Figure 4: Comparison of visualization effect.

From Figure 4, it can be seen that the visual images drawn by the system in this paper have good transparency and visualization effect, and the image clarity is high. The models drawn by the sensor-based visual communication digitizing system and the feature extraction-based visual communication digitizing system have higher grayscale value, poorer transparency, poorer clarity and poorer visual communication effect. For example, inserting dynamic image information in the process of reading static information, although abruptly but can make the communication more interesting appear in different spaces. For example, the design of e-books and paper books can convey the same information in different media and show the advantages of each. With 3D augmentation technology, information content can be split into real and virtual parts, or virtual content can be presented in real space. Jumping narrative, jumping from one message to another, omitting several messages in between. In the integration of multiple media, it is common that not all the media used in the message are accessible to each audience, as each audience has different access to the media, and some of them are omitted. To verify the performance of the system in this paper, 12 professionals were invited to test the system, and the performance is shown in Figure 5.

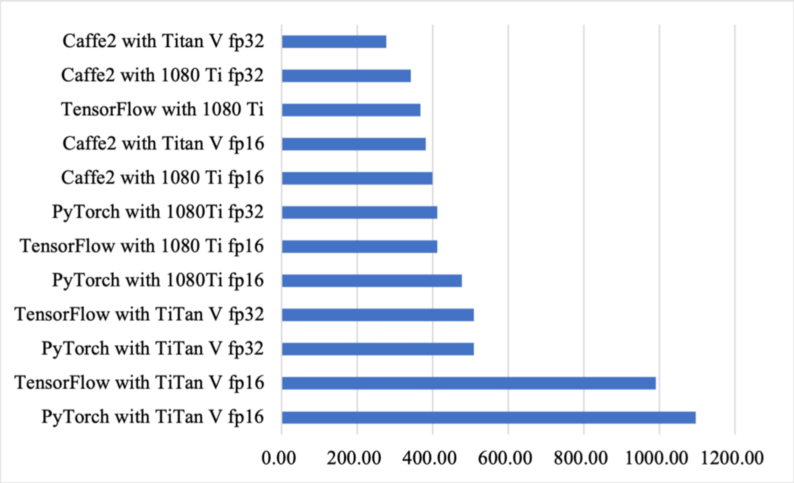

Figure 5: System performance test.

The system was tested to be able to successfully build a digital packaging model with visual communication effects and has good performance in the actual use. In the process of drawing the image of white wine packaging, the size of the image affects the drawing time, and the time required to draw the image for different image sizes is compared with the other two methods. With the growth of the image size, the drawing time gradually increases, but the system in this paper always stays within 4s, indicating that the drawing efficiency of this system is high, which can improve the efficiency in the process of actual use.

However, it will have a subtle impact on the mood and emotion of users, thus swaying their operation behavior. Only when users experience pleasure, the process of conveying information will be relatively smooth. Finally, fluency is also closely related to the design medium and tools. Real-time links realized based on IoT technology can not only make the performance of design themes more complete and diversified under cross-media design, but also the audience can have a more fluent design experience. According to their own design concepts, designers optimize the selection of communication media with full consideration of the reach rate of the media and the contact effect between the target audience and the media, reasonably construct the communication structure and sequence, and pay attention to the effect of time, action and media switching in the media fusion, so as to effectively reduce the communication noise and make the message more accurate.

4.2 Analysis of Results

The energy consumed by the system in drawing the image also differs. The energy consumed by this system and the other two systems in drawing the image is shown in Figure 6.

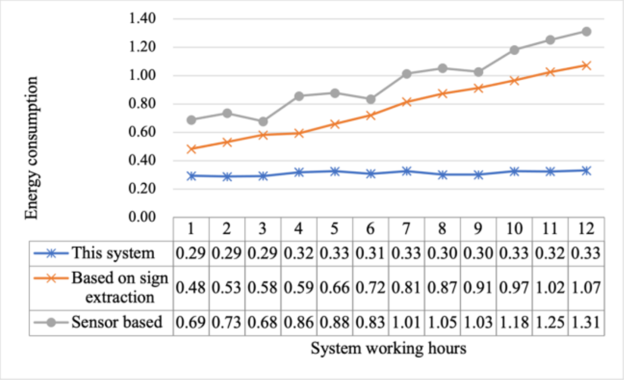

Figure 6: Energy consumption comparison chart.

From Figure 6, it can be seen that the energy consumption of this system does not change much with the increase of system usage time, and always remains below 0.45 J with a stable trend. From Figure 6, it can be seen that the system in this paper consumes the least amount of energy when designing the packaging of the experimental object, which can bring better efficiency to the enterprise in the actual use process.

The real-time link based on IoT technology not only makes the design theme more complete and diversified, but also gives the audience a more smooth design experience. According to their own design concept, designers optimize the selection of communication media with full consideration of the reach rate of media and the contact effect between target audience and media, reasonably construct the communication structure and sequence, and pay attention to the effect of time, action and media switching in media fusion, so as to effectively reduce communication noise and make the message more accurate. As shown in Figure 7.

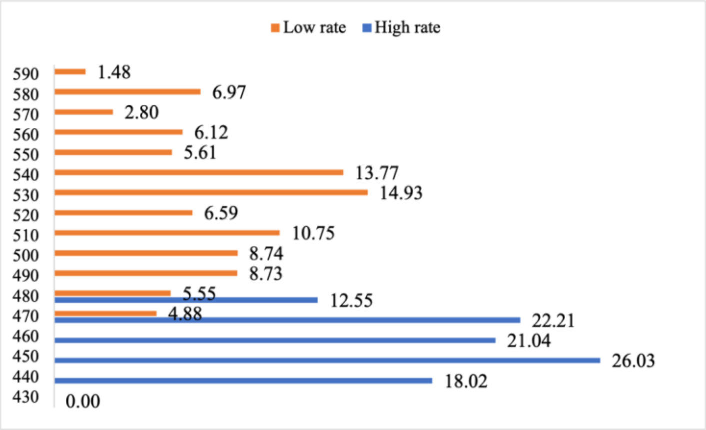

Figure 7: Distribution histogram obtained for high speed (50 cmmin-1) and low speed (2 cmmin-1).

For the study of Web2.0 visual design style, we explore its design laws and aesthetic interests through styling methods, structural layout, and color orientation, and as a theoretical basis for developing new media art design styles. the typographic layout (difficulty) of Web2.0 websites can be minimal. Making good use of whitespace can make the focus prominent, easy to read, and easy to use. As in Figure 7, whitespace brings out important information, allows the eye to rest, and gives a sense of stability and order. Loose line spacing also makes it easy for the eye to follow the flow of text. Clever use of typography, color, font, and text keeps the user comfortable for long periods of time while reducing visual physiological pain and making the reader more approachable.

Internet of Things technology is an extension of the Internet, so the visual communication design under Internet of Things technology must have the characteristics of virtual aesthetics, but at the same time it must be linked to real "things", so it also needs the guidance of traditional aesthetics. At the same time, the transcendental, experiential and technical characteristics of virtual aesthetics also influence traditional aesthetics, and there is a great breakthrough in terms of aesthetic freedom and expansion of form and content.

5 CONCLUSION

The redesign of multi-media fusion has become its new design content, emphasizing the diversity of design experience, inter-temporality of communication, non-linear narrative and personalized information content, so as to give audiences intertextual and smooth information interaction and experience. However, although the innovation and development of media have changed people's lifestyles and the forms of visual communication design have become more diverse, they have not changed the main function of design.

Leilei Yang, https://orcid.org/0009-0008-5502-8613
Yi Zhang, https://orcid.org/0000-0002-0959-2853

REFERENCES

[1] Blas, M.-J.; Gonnet, S.: Computer-aided design for building multipurpose routing processes in discrete event simulation models, Engineering Science and Technology, an International Journal, 24(1), 2021, 22-34. https://doi.org/10.1016/j.jestch.2020.12.006

[2] Colla, D.; Goy, A.; Leontino, M.; Magro, D.; Picardi, C.: Bringing semantics into historical archives with computer-aided rich metadata generation, Journal on Computing and Cultural Heritage (JOCCH), 15(3), 2022, 1-24. https://doi.org/10.1145/3484398

[3] Lee, J.-W.; Maria, S.-M.-A.; Vu, T.-N.-L.; Yoon, S.; Choi, S.: Big data and artificial intelligence (AI) methodologies for computer-aided drug design (CADD), Biochemical Society Transactions, 50(1), 2022, 241-252. https://doi.org/10.1042/BST20211240

[4] Liu, K.; Zhao, Z.; Shi, P.; Li, F.; Song, H.: Real-time surgical tool detection in computer-aided surgery based on enhanced feature-fusion convolutional neural network, Journal of Computational Design and Engineering, 9(3), 2022, 1123-1134. https://doi.org/10.1093/jcde/qwac049

[5] Maćkowski, M.; Żabka, M.; Kempa, W.; Rojewska, K.; Spinczyk, D.: Computer aided math learning as a tool to assess and increase motivation in learning math by visually impaired students, Disability and Rehabilitation: Assistive Technology, 17(5), 2022, 559-569. https://doi.org/10.1080/17483107.2020.1800116

[6] Pando, C.-P.; Fernández, Á.-H.; Busto, P.-B.; Castano, B.-S.: Boosting computer-aided design pedagogy using interactive self-assessment graphical tools, Computer Applications in Engineering Education, 31(1), 2023, 26-46. https://doi.org/10.1002/cae.22569

[7] Reyes, E.; Sonesson, G.: New approaches to plastic language: Prolegomena to a computer-aided approach to pictorial semiotics, Semiotica, 2019(230), 2019, 71-95. https://doi.org/10.1515/sem-2018-0106

[8] Wang, R.: Computer-aided interaction of visual communication technology and art in new media scenes, Computer-Aided Design and Applications, 19(S3), 2021, 75-84. https://doi.org/10.14733/cadaps.2022.S3.75-84
[9] Zhang, N.: Application of computer graphics and image software in marine graphic design, Journal of Coastal Research, 106(SI), 2020, 600-604. https://doi.org/10.2112/SI106-136.1
[10] Ziatdinov, R.; Valles, J.-J.-R.: Synthesis of modeling, visualization, and programming in GeoGebra as an effective approach for teaching and learning STEM topics, Mathematics, 10(3), 2022, 398. https://doi.org/10.3390/math10030398