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Research on Visual Communication Design Based on Computer-Aided Systems

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Abstract. In the digital age needs to meet people's diverse needs, with various styles and rich presentations. In order to fully utilize the advantages of computer-aided technology and improve the level of visual communication design, an effective method is proposed. Firstly, the correspondence table between executing actions and executing mechanisms is established from the perspective of mechanism, in order to achieve precise calculation of error distance, and a visual communication partition model is established. Secondly, to select the optimal solution for the executing mechanism system, an evaluation system for executing mechanism system solutions, mathematical model, and a solution method based on genetic algorithms are established. The scientific coding of coefficient constraint features is realized, and the corresponding hyperplane is determined to obtain the relevant parameters of visual communication. Finally, through innovative technology-assisted expression, the image expression effect of visual communication can be greatly improved. Experiments show that the computer-aided visual communication design method has high reliability and feasibility. By applying it to image recognition with different complexities, the accuracy of image recognition can be effectively improved, thereby obtaining good visual communication effects.

Keywords: Visual Communication Design; Digital Age; Computer-Aided; Genetic Algorithm.
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1 INTRODUCTION

Visual communication design is an important design method, mainly used for the effective transmission of content through images and graphics. This design usually involves graphic style,

color, and layout, greatly enhancing the richness and variability of graphic works. In repairing complex defects in the mandible. Bakkouri and Afdel [1] improve the performance of machine learning by learning from one task and applying it to another task. In CAD systems, transfer learning can be used to learn from existing CAD models and apply them to new CAD tasks. This method can help robust CAD systems design and model in different environments. A robust CAD system is a system that can accurately model and design in complex environments. It needs to have high robustness and stability in order to design and model in various different environments. Transfer learning and multi-layer feature fusion network are two commonly used technologies, which can be used to build robust CAD systems. Integrating images with the patient's anatomical structure is a challenging task, as it requires combining medical images with human anatomical knowledge to create an accurate, reliable, and suitable anatomical model for the patient. 3D modeling using medical images: 3D modeling of medical images can be used to create anatomical models of patients [2]. Cai et al. [3] used computer vision technology to extract and analyze the anatomical structure of patients and convert it into a form that computers can understand. These technologies include computer-aided design and manufacturing (CAD/CAM), digital medical imaging technology, and computer-aided manufacturing. Chan et al. [4] believe that CAD systems based on deep learning and artificial intelligence can be constructed through the following steps. Collecting and processing CAD data: Deep learning and artificial intelligence technologies can be used to process and analyze CAD data. These data can come from different fields such as medical images, mechanical parts and architectural model. Building a deep learning model: Deep learning technology can be used to construct a deep learning model, which can automatically learn and adaptively adjust, thereby improving the accuracy and robustness of the model. Use a large amount of CAD data to train deep learning models and apply them to CAD design and modeling. These data can come from different fields such as medical images, mechanical parts and architectural model. Collins et al [5] analyzed an automated computer-aided diagnosis (CAD) tool. It can quickly detect colorectal cancer and esophageal gastric cancer tissues in optical images. This has great value for surgeons during interventional treatment.

Hou et al. [6] can help improve production efficiency and quality in fields such as industrial manufacturing and healthcare. By utilizing computer-aided technology, defects, anomalies, and other issues in X-ray images can be automatically detected, thereby improving product quality and production efficiency. These technologies include machine learning, deep learning, artificial intelligence, and more. Jeyaraj et al. [7] can automatically detect defects, flaws, anomalies, and other issues in fabrics, thereby improving product quality and production efficiency. Fabric defect classification: By using learning algorithms, defects, anomalies, and other issues in the fabric can be classified, thereby improving the accuracy and reliability of classification. Fabric defect morphology analysis: By using learning algorithms, morphology analysis can be performed on defects, flaws, anomalies, and other issues in the fabric, thereby improving the accuracy and reliability of morphology recognition. The following are some commonly used learning algorithms and techniques that can be used for fabric defect detection and classification. CNN is a popular deep learning method that can be used for tasks such as image segmentation, object detection, and semantic segmentation. CNN can be used in fabric defect detection and classification by extracting features from fabric images and classifying them, thereby achieving automatic detection and classification of fabric defects. Jiang et al. [8] Computer assisted visual converter (ViT) is a converter designed for visual processing tasks. It can find its initial application in natural language processing (NLP) tasks, as shown in BERT, GPT-3 and other language models. In contrast, typical image processing systems use convolutional neural networks (CNN). These parts (with positional embeddings) are placed in a sequence. Embedding is a learnable vector. Jiménez et al. [9] believe that each part is arranged as a linear sequence and multiplied by the embedding matrix. The results with positional embeddings are fed into the converter. Mohamed and Khairi [10] introduced a face recognition system based on computer-aided design. The proposed design system is based on detecting faces, mouths, and noses in captured images. The CAD system is considered to be implemented for specialized respiratory hospitals in different departments, with each department controlled by a separate door. The system helps to reduce the spread of respiratory diseases and controls the wearing of masks in hospitals with

respiratory infectious diseases based on mask detection and mask color detection. Montalbo [11] With the help of transfer learning, this model has an initial leverage. Pre training weights from COCO data sets can be used to train more quickly to generate a set of robust.

In the process of research, designers can examine the application of design forms from a dynamic perspective, thereby achieving effective information transmission. The article is divided into four chapters. Chapter one mainly discusses the research status of visual communication design under computer-aided systems in the context of the domestic and international development of visual communication. Chapter two mainly discusses the new visual development characteristics of visual communication design and traditional fusion under the conversion of computer-aided systems. Based on the problem description and analysis of genetic algorithms, the adaptability of dynamic visual communication design is analyzed, and the analysis and verification are carried out based on the execution mechanism system and its design requirements [6]. Chapter three designs comparative simulation experiments to verify the applicability and feasibility of the computer-aided system constructed in this paper to break through the static plane effect of traditional visual communication design. At the same time, the accuracy verification and efficiency analysis of the computer-aided system in the data processing process are conducted. The experimental results show that the new visual communication design method proposed in this paper greatly improves the accuracy of image recognition, increasing it to 87.13%. However, since this experiment did not compare and analyze the recognition efficiency and different data volumes, it cannot be ensured that this design method can achieve good visual communication effects in various scenarios. Therefore, technicians need to pay attention to supplementing and improving this content to further improve the visual communication effect.

2 STATE OF THE ART

Augmented reality and hybrid reality technologies have been widely applied in various stages of the product lifecycle to enhance the attractiveness, user experience, and sales and profitability of products. Tanaka et al. [12] proposed that virtual reality technology can be used for product design. It can enable users to design products in a virtual reality environment, thereby improving the efficiency and accuracy of product design. Reduce the risks and costs of product design. Augmented reality technology can be used for product testing, allowing users to conduct product testing in a virtual reality environment. In order to improve the efficiency and accuracy of product testing, and reduce the cost of product testing. Hybrid reality technology can be used for product launches, allowing users to conduct product launches in a virtual reality environment, thereby improving the efficiency and accuracy of product launches, increasing product exposure and sales opportunities. Yan et al [13] proposed a technology based on computer vision to monitor the risk of collision, but there are shortcomings such as spatial relationship distortion caused by pixel estimation based on two-dimensional (2D) images. Yu and Shi [14] analyzed that computer-aided visual communication refers to the process of using computer-aided technology for visual communication design and creation. Computer aided technology can include computer graphics, computer vision, machine learning and other technologies, and can be used in image processing, image analysis, image recognition, visual communication design and other aspects. In visual communication design, computer-aided technology can help designers quickly and accurately process and analyze images, thereby better carrying out design and creation. Zhang et al. [15] believe that computer-aided technology can be used for tasks such as automatic classification, recognition, and annotation of images. This can greatly improve the work efficiency and quality of designers. In addition, computer-aided technology can also be used for visualization in visual communication design. The designer's design scheme can be visually displayed through computer graphics technology, so as to better convey and promote. Computer vision plays an important role in the autonomous vehicle, which can help the vehicle achieve autonomous decision-making and control. For example, cars can obtain information about their surrounding environment through sensors such as cameras and LiDAR, thereby achieving functions such as automatic lane changing and obstacle avoidance. Zhu et al [16] developed an efficient, accurate, and non-invasive gentamicin detection method, which can provide

timely feedback for high-throughput screening of high-yield strains. Research on updating validated new datasets on the model database to improve the learning ability of DBTL loops. Computer vision can be used for medical imaging diagnosis, which can help doctors quickly and accurately diagnose diseases. For example, computer vision can be used for automatic analysis and diagnosis of lung CT images, which can help doctors quickly and accurately diagnose and treat lung diseases. Computer vision can be used in urban traffic monitoring systems to achieve real-time monitoring and early warning of urban road traffic conditions. For example, computer vision can be used for automatic recognition and control of traffic lights, which can help urban traffic management departments better carry out traffic scheduling and management.

It can compare each designed product, identify defects in the finished product, generate new logic based on the defects, and then select and compare the design results to obtain the best work. This process can ensure the quality of visual communication design. In the traditional visual communication design process, designers often repeat a certain design step extensively and constantly modify the design draft, resulting in low design efficiency. The application of computer-aided systems can directly repeat the entire design process, compare multiple results, and the efficiency of this design method in a single design far exceeds the corresponding design efficiency of designers, as shown in Figure 1.

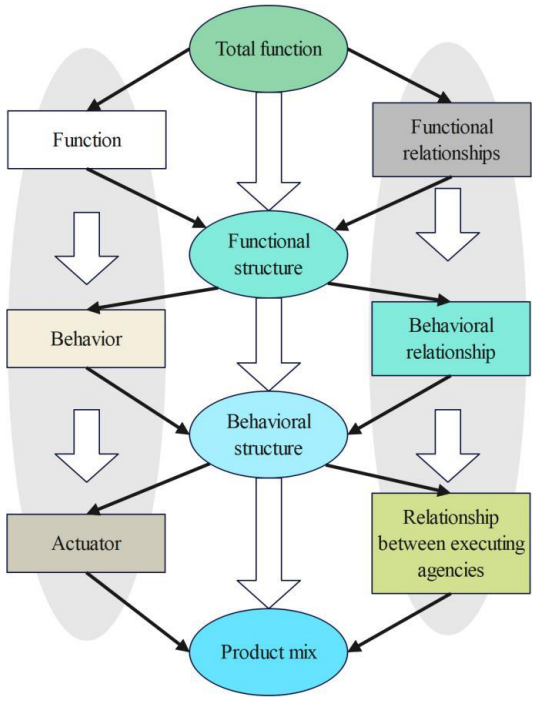

Figure 1: Conceptual design model framework of execution system.

With the development of society, the main direction achieved by designers with professional skills through manual design. It is difficult to integrate multiple design elements in design, and human errors can lead to problems such as repetition and lack of creativity, resulting in slow development of diversified visual communication design. The introduction of computer-aided systems in visual communication design can effectively solve corresponding problems. This is because computer-aided systems view visual communication design as a program and utilize various technologies for design,

taking on the role and functions of terminal control systems. It can organically integrate various design elements and promote diversified design development.

3 METHODOLOGY

3.1 Analysis of Execution System and its Design Requirements

The selection of individuals is based on the fitness value, and different problems have different fitness functions. Individuals with higher fitness values have more opportunities for selection in the next generation, while those with lower fitness values produce fewer offspring in the next generation and are gradually eliminated. Through this screening, the quality of the population improves generation by generation, and the optimal solution is eventually obtained. Currently used selection operators include the following:

$$Pi = \frac{fi}{\sum_{i=1}^{N} fi} \tag{1}$$

However, this also implies a crisis, that is, the genetic genes of local optimal individuals will rapidly increase, causing the evolution to possibly fall into a local solution. In other words, the global search ability of this method is poor and it is more suitable for searching single-peaked search spaces rather than multi-peaked search spaces, so this method is generally used in combination with other selection methods.

$$V = \frac{F}{C} \tag{2}$$

In the formula, V represents value, F represents function, and C represents life cycle cost.The basic idea of the tournament selection model is to select the individual with the highest fitness from several individuals each time and pass it down to the next generation of the population.

$$k_N = \sqrt{N} \tag{3}$$

N represents the total number of training samples. Using the trial-and-error method, 50 hidden nodes were selected.

3.2 Design of Dynamic Visual Communication

This requires a shift in the designer's thinking, thinking from a multidimensional and three-dimensional perspective in design creation. When performing the crossover operation in the genetic algorithm, generate a random number r from [0,1], if r<Pc, select Vi as a parent. Let V1, V2, ... represent the selected parents above, and divide them randomly into the following pairs."

$$(V_1, V_2), (V_3, V_4), (V_5, V_6), \ldots \tag{4}$$

If the number of parents is odd, one chromosome can be removed or another chromosome can be selected to ensure pairing. Take (V1, V2) as an example to explain how to perform crossover operations on all pairs. The first method is simple crossover. Assume that chromosome V1=(a1,a2,...,an) and V2=(b1,b2,...,bn). Two crossover points j and k (j<=k) are randomly generated between 1 and n. Two offspring are formed by exchanging the genes of the jth to kth genes of chromosomes V1 and V2.

$$X = \left(a_1, \ldots, a_{j-1}, b_j, \ldots b_k, a_{k+1}, \ldots, a_n\right) \tag{5}$$

$$Y = \left(b_1, \ldots, b_{j-1}, a_j, \ldots a_k, b_{k+1}, \ldots, b_n\right) \tag{6}$$

$$X = c \cdot V_1 + (1-c) \cdot V_2, \quad Y = (1-c) \cdot V_1 + c \cdot V_2 \tag{7}$$

When the newly generated offspring is infeasible, some repair strategies can be adopted to make it a feasible chromosome. The crossover strategy used in this article is an improved form of the first method. When performing the crossover operation, a random number n is selected, and then n random numbers c1, c2, ..., cn are generated as n crossover points between the two chromosomes, and the crossover operation is performed. Therefore, the first crossover strategy introduced earlier is actually a special case, that is, the n=1 case.

Compared with static text, the content of dynamic text design mainly focuses on the change of font movement and the creation of form, and many unforeseen possibilities may arise in the process of motion and change. Static fonts focus on form design, while dynamic fonts emphasize the expression of information in time through dynamic relationships. The dynamic presentation of text is controlled by frame sequences, where key frames are the start and end of an action, and the number and density of intermediate frames control the speed and rhythm of motion. The key frame is the starting node of the motion, and the intermediate frame presents a motion frequency that gradually slows down from dense to sparse, or vice versa, gradually increasing from slow to fast, adjusting the motion rate through intermediate frames.

3.3 Problem Description and Analysis Based on Genetic Algorithm Testing

The proposal of any algorithm first stems from the need to solve a certain problem or class of problems, and the improvement of the algorithm is often due to the expansion of the problem domain or higher requirements. This article mainly focuses on the latter, that is, to obtain more accurate solutions to function optimization problems. The algorithm's step-by-step process is shown in Figure 2.

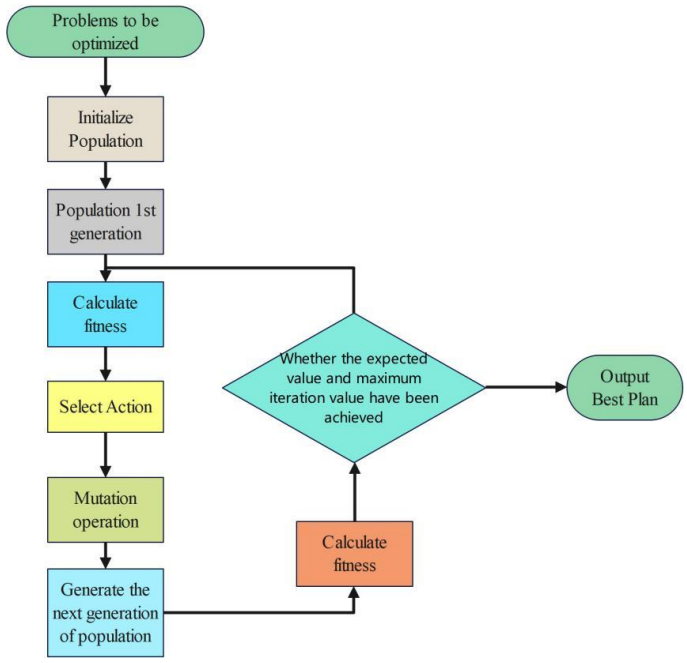

Figure 2: Flowchart of Improved Genetic Algorithm.

The most common application of evolutionary algorithms is for optimization problems, and conversely, using the effect of solving optimization problems to verify the performance of algorithm improvements becomes the preferred work. Classic optimization problems include function optimization problems and combinatorial optimization problems. This article takes function optimization problems as the testing target to verify the effectiveness of the algorithm. Without loss of generality, the form of seeking the optimal solution for function solving is:

$$\min f(x) \tag{8}$$

$$\text{subjet to } x \in \Omega \tag{9}$$

For ease of describing the genetic algorithm, the optimization problem is set as a minimization problem. Here, x is the decision vector, f(x) is the objective function, and Ω is the decision space. The standard genetic algorithm uses binary encoding, which is not ideal for function optimization problems, leading people to gradually turn to particle swarm optimization algorithms, differential evolution algorithms, and so on. The objective function is directly used as the fitness function, namely:

Maximization problem

$$Fit(f(x)) = f(x) \tag{10}$$

Minimization problem

$$Fit(f(x1)) = f(x1) \tag{11}$$

The roulette wheel selection method is used to select individuals in the population. First, the fitness values of individuals in the population are calculated based on the fitness function, and then the total fitness value of the entire population is obtained. The probability of each individual being selected is calculated based on the ratio of its fitness value to the total fitness value of the population. The specific formula for each step is as follows. The formula for calculating the total fitness value of the population is as follows (12):

$$\sum_{i=1}^{n} f(i) \tag{12}$$

Secondly, calculate the probability of each individual being selected (pi):"

$$p(i) = \frac{f(i)}{\sum_{i=1}^{n} f(i)} \tag{13}$$

Finally, calculate the cumulative probability of the individual:

$$q(i) = q(i-1) + p(i) \tag{14}$$

For the above formula, when i = 0:

$$\delta^{j} = \sum -diff\left(x_i^j, x_{i,nh}^j\right)^2 + diff\left(x_i^j, x_{i,nm}^j\right)^2 \tag{15}$$

By using the method of preserving the best individuals, the best individual is not involved in the crossover and mutation process, which speeds up the search speed of the genetic algorithm.

4 EXPERIMENTAL RESULTS AND ANALYSIS

4.1 Dynamic Expression of Graphics and Images

As shown in Figure 3, Jonathan Jarvis visualized the emergence of the U.S. subprime mortgage crisis with dynamic information graphics.

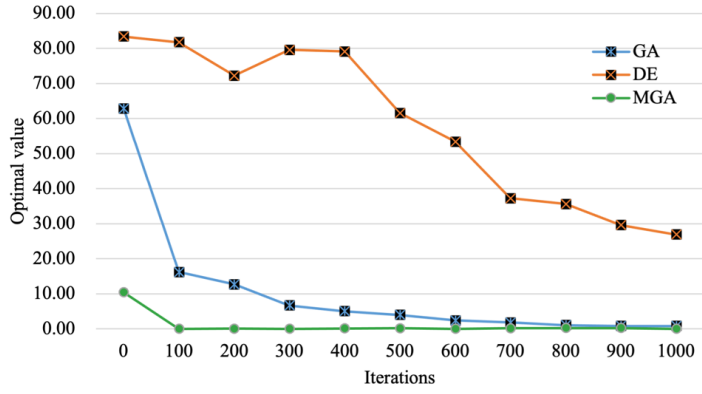

Figure 3: Convergence results of function f1 under different algorithms.

By analyzing the convergence of the 12 functions in Figure 3, it can be seen that the DE algorithm had outliers in the f2 function graph. In terms of the comparison of the convergence speed of the three algorithms, the MGA algorithm is better than the other two algorithms, which once again confirms that the improvement of the genetic algorithm is effective. Due to the movement and changes in the text, the reading experience is brief, forming an information impression in people's minds through visual persistence.

4.2 Experimental Simulation and Analysis

60000 training sets and 10000 test sets from the MNIST database were used for evaluation. After assigning weights to the feature encoding method, the improved genetic algorithm was used to find the optimal feature subset, and then the KNN classification algorithm was used for testing. In order to ensure the effectiveness of the GA_KNN algorithm, considering that the choice of K value has an impact on the accuracy of the classifier, the best K value was found under the same conditions. As shown in Figure 4, the classification effect is best when the K value is 7.

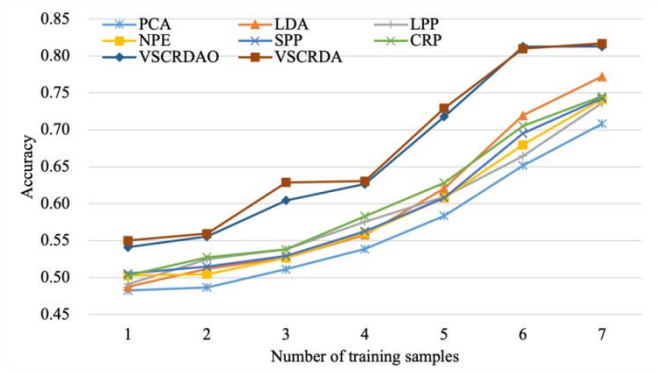

Figure 4: Changes in classifier recognition rate with different K values.

The comparison of the recognition rate under different K values in Figure 4 was used to determine the appropriate K value. When the K value is less than 4, the recognition rate is very low. When the K value is between 4 and 7, the difference in recognition rate is small. Through experimentation, it was

found that the recognition rate is highest when the K value is 7. Therefore, the GA_KNN feature selection experimental results corresponding to a K value of 7 are shown in Figure 5.

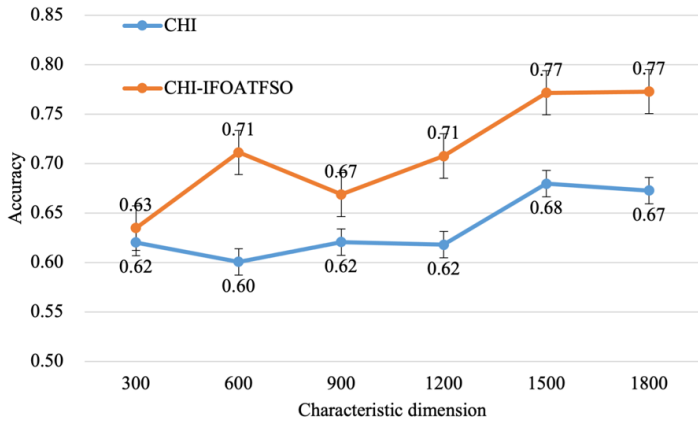

Figure 5: Number of features and classifier recognition rate under different weights.

It can be seen from Figure 5 that the number of features is greatly reduced and the recognition rate of features is improved when assigning weights to the features using different encoding methods. This indicates that assigning weights to sample data is effective. The motion effect of text is mainly governed by the speed and direction of motion. The motion direction of text depicts the motion trajectory, which is generally divided into three types: straight, curved, and parabolic. In dynamic design, the motion speed is an important key to express the meaning of text, which controls the rhythm of the entire information transmission. Different text motion speeds will bring different psychological feelings to people. Fast motion will produce tension, vitality, speed, and jumping emotions, while slow motion will bring relaxation, calmness, and peace. Accurately expressing information by adjusting the motion speed and trajectory.

4.3 Results and Analysis

This feature is more prominent than other art forms. Based on the characteristics of dynamic visual communication and digital media, because the implementation of dynamic design depends on technology, many designers often indulge in the special effects production of text when designing. This design only stays at the technical level. When dynamic text is given a certain concept or information, it becomes an emotional symbol with vitality, which realizes its value. The improved algorithm TOC-MPGA performs better than the ordinary GA in solving the 30-city traveling salesman problem in terms of optimization performance. In terms of convergence speed, GA tends to be stable at around 270 iterations, while TOC-MPGA tends to be stable at around 120 iterations. In terms of convergence accuracy, the result obtained by GA after 500 iterations is significantly inferior to that of TOC-MPGA. The results are shown in Figure 6.

From Figure 6, it can be seen that the improved algorithm TOC-MPGA performs better than the ordinary GA in terms of optimization performance when solving the problem. In terms of convergence speed, GA did not achieve convergence stability within 500 generations, while TOC-MPGA tended to be stable at around 400 generations. In terms of convergence accuracy, the shortest city distance obtained by GA after 500 iterations is significantly higher than that obtained by TOC-MPGA, indicating that the convergence accuracy of TOC-MPGA after 500 generations is better than that of GA.

From Figure 7, it can be seen that TOC-FPGA tends to be stable at around the 15th generation, and TOC-CPGA tends to be stable at around the 5th generation. Both algorithms can approach the optimal solution at a relatively fast speed, but the ordinary genetic algorithm will stay at a certain

local value for a long time and tend to be stable at around the 20th generation. It can be seen that both TOC-FPGA and TOC-CPGA have a relatively fast convergence speed when seeking the optimal value of the Sphere function, and can quickly jump out of local optimal values and find the global optimal value.

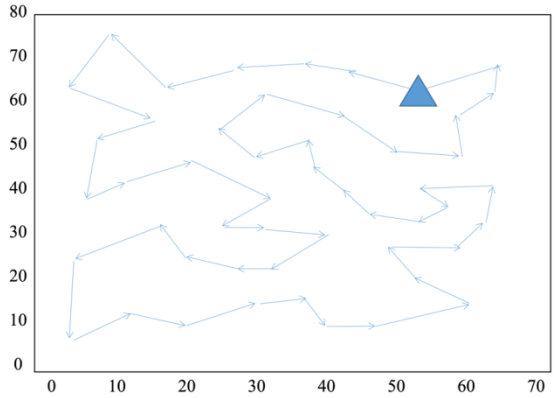

Figure 6: Optimal path diagram before and after genetic algorithm optimization for visual design.

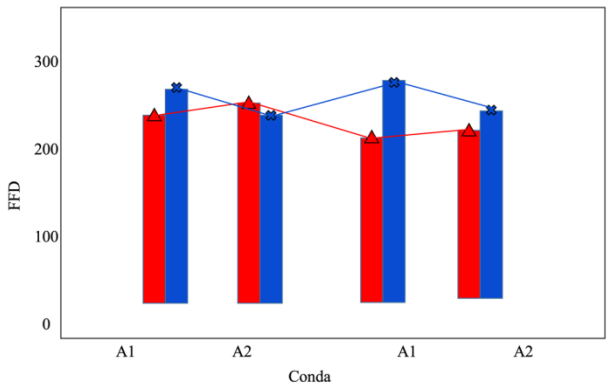

Figure 7: Convergence diagrams of two paths for the Sphere function.

TOC-FPGA and TOC-CPGA both make full use of the characteristics of three-valued optical computer processors, which have many data bits and can be grouped, as well as the parallelism of genetic algorithms, and have improved the genetic algorithm. Both parallel algorithms use the parallelism of genetics, can better search the solution space, maintain population diversity, effectively suppress the occurrence of genetic algorithm premature convergence problems, and improve the optimization efficiency of genetic algorithms.

5 CONCLUSION

This paper mainly studies how to achieve innovative design forms in visual communication design under computer-aided systems, and realizes more efficient and user-friendly information transmission based on the new characteristics brought by digital media. With the information revolution, digital media, which is centered on computer-aided systems and network technology. This paper proposes rule-based innovative design methods and feature-based innovative design ideas. Based on this, evolutionary operations are carried out to generate entities of various types.

Feature-based innovative design is a kind of innovative design thinking that transforms product design into the definition of product features. Therefore, innovative design uses the relevant theory of genetic algorithms to evolve product features, making them reasonable or satisfying certain aspects of user requirements. In addition, it also provides a way of thinking for the research of genetic algorithms and innovative design in the future.

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