

Research Article

Optimization of Cultural and Creative Product Design Based on Simulated Annealing Algorithm

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This paper introduces the basic principle and application process of simulated annealing algorithm and improves the simulated annealing algorithm so that it can converge faster to get the new parameters of cultural and creative product design and make it more in line with the reality of engineering optimization. In the cultural creative industry, it is necessary to use the creator's creativity and technology to derive and develop the original cultural resources with the help of various materialization means, to refine the abstract and profound contents of cultural resources to make them more visualized, and to produce products with both spiritual and economic values through the multiple development and utilization of their intellectual property contents. By studying the feasibility analysis of the cultural and creative design, the design positioning of the cultural and creative products is determined. In this article, we use the simulated annealing method to simulate and analyse the condition values in the design process of cultural creative products. As the Internet era progresses, people have more diversified requirements for cultural and creative products, and they need to have innovative ideas to follow the trend, so the design of cultural and creative products can spread culture through different design expressions and media. As one of the important pillar industries for future development, cultural and creative products are characterized by a wide range of styles and practicality, which meet the aesthetic needs and fashion trends of modern people.

1. Introduction

Cultural creation refers to the process of extracting and reconstructing the culture of an established audience with an innovative approach and generating the product, which is short of cultural creative products for the display and dissemination of culture. With the development of culture and economy, cultural and creative products are becoming increasingly abundant and have set off a boom [1]. At the level of artistic innovation, the design research of cultural and creative products is also beneficial to analyse previous cultural and creative cases, which can provide better value to the design [2–4]. Through the existing cultural and creative derivatives, a thorough study of the qualities of the development of the product itself and the design development trend and the exploration of diversified expressions of cultural and creative products can make the heavy Tang culture into modern life so that people can let people experience the splendour of culture.

Modernity and tradition are not in conflict with each other. With the development of cultural and creative industries, increased people are keen on interesting and beautiful cultural and creative products, and small and exquisite cultural and creative products often bring a better experience to travel or visit. Excellent traditional culture is the spiritual force for the development and progress of human civilization, and the development of cultural and creative products can bring excellent heritage culture into people's lives and get better protection and inheritance [5]. Museums should not be just places for cultural relics researchers, and nonheritage culture and historical culture should not be just the culture that history lovers pay attention to [6, 7]. How to transform culture into tangible cultural products and digitally transform it into people's lives is a problem worthy of research today.

From the perspective of practical value, the application of marine life forms in soft pottery sculptures can provide an

example of soft pottery sculpture cultural and creative product design inspired by marine life forms, and this example can provide reference ideas and experience for more similar products and designs. This reference is not only artistic but also practical [8]. Marine life forms have always been a popular element of marine cultural creative products, and there are many tourism creative products designed and sold with this inspiration. The thesis and graduation design formed through the research can provide some reference for the design and sale of this aspect and help practitioners design more excellent cultural and creative products of soft pottery colorful sculpture applying marine biomorphic elements. Optimization technology is an applied technology based on mathematics, which is used to solve various engineering problems. At the same time, the theoretical study of optimization methods plays an important role in improving the performance of algorithms, broadening their application areas, and improving their systems.

2. Related Studies

Wen et al. used a design method with a compression factor to select the parameters of the algorithm and studied the convergence of the annealing algorithm [9]. Seifollahi et al. focused on the convergence of the SA algorithm based on the previous conclusions and proved through a large amount of experimental data that the SA algorithm can converge at a certain point in space but the final convergence result is not globally optimal [10]. Jqa et al. questioned the then famous discrete SA algorithm, introduced a new continuous SA algorithm and proved that this proposed continuous SA algorithm is globally asymptotically stable [11]. Eswari et al. changed some of the particles and assigned a particle weighting factor to a certain extent which can avoid the algorithm from falling into the local optimal solution prematurely and accelerate the convergence speed of the algorithm [12]. Zhu et al. studied the selection range of algorithm parameters and demonstrated the enhanced convergence of the algorithm after introducing constraints such as inertia weight parameters and acceleration coefficients through simulation experiments [13]. Many scholars have discussed the specific characteristics of marine elements in terms of form, color, and pattern, and texture which made certain theoretical sublimation of them and made a creative practice in clothing, illustration, commodity packaging, and cultural creative products. Some papers suggest that the design of cultural and creative products using marine elements should focus on the discovery of marine culture, refine the morphological symbols, streamline characteristics of marine creatures, and constantly innovate in design and color; it should be dedicated to meet multilevel needs and satisfy people's aspirations for the ocean, to awaken people's environmental awareness of caring for the ocean and cherishing marine creatures [14]. It can be found that when using marine elements for art design and creation, the aesthetic characteristics of the work must be linked with the deep-seated marine culture to achieve a more profound artistic value.

Zhang et al. discussed the application practice of marine creatures in illustration design and suggested that the posture of marine creatures is often very different from that of land creatures and thus has a unique artistic and aesthetic value, and the extraction and reconstruction of their geometric elements and the strengthening of their curvilinear features have a unique value in artistic creation [15]. del Rio-Chanona et al. introduced the current situation of marine tourism cultural products and the problems existing in them and put forward strategic suggestions for the design of marine tourism cultural creative products from three aspects: product type, cultural connotation, and material texture [16]. Gherardini et al. used marine creatures as the source of inspiration for their cultural, and creative products should not simply stay on the superficial idea of marine conservation but should be devoted to meet multilevel needs and satisfy people's yearning for the ocean, to awaken people's environmental awareness of caring for the ocean and cherishing marine creatures [17]. The aesthetic potential and artistic properties of soft pottery are also affirmed through practical creation, and it is believed that designing artworks with soft pottery as the material can create soft pottery colorful sculptures with various styles and rich colors and shapes [18]. The organic combination and application of soft pottery production techniques and creative methods can bring new opportunities for the creation of soft pottery artworks.

In the process of research, it can be found that while there are commonalities among the cloud shoulders of different periods, they also have their individuality, and thus the typical patterns and cloud shoulder forms they present may differ. However, this was given to them by the times and by the craftsmen, who put a lot of emotion and effort into making them, making them unique and unrepeatable. Unfortunately, because traditional costumes gradually could no longer meet the needs of people's lives, the cloud shoulder slowly began to fade out of sight and was transformed into theater or stage costumes and later developed into a folk wedding costume. However, the unique shape, color, pattern, and craft details of the cloud shoulder are still worth learning and learning from modern people. To conduct a complete study of our purpose, we need to discuss it from a combination of theory and experiment.

3. Simulated Annealing Algorithm for Design Analysis of Cultural and Creative Products

3.1. Improved Simulated Annealing Algorithm. The simulated annealing algorithm (SA) was first proposed by Metropolis and was used by Kirkpatrick for combinatorial optimization. The starting point of the simulated annealing algorithm is to simulate the physical annealing process in nature and combine it with a mathematical iterative solution strategy, which can be used to solve optimization problems in various engineering projects [19]. To prevent the entire search process from falling into the local minimum closest to the initial point, the simulated annealing method determines the optimization process based on the Boltzmann probability distribution. The algorithm can accept solutions with a

lower probability than the previous result. Iteration makes the entire cooling process of simulated annealing slow, thereby ensuring that the system reaches the lowest energy state, which means that the optimization search converges to the global minimum [20]. The basic idea of the simulated annealing algorithm is the physical annealing process in nature, so let us first discuss the physical annealing process. Briefly, physical annealing consists of three processes, which are the heating process, isothermal process, and cooling process.

The proposed simulated annealing algorithm is based on the high-temperature solid annealing process in statistical thermodynamics, where physical annealing first goes through the thermodynamic process of heating to melt the solid and then slowly cooling the molten so that it solidifies again into a regular crystal. In the process of heating, the atoms inside the metal are in a disordered state of high velocity and high energy, and then the temperature is lowered and the atoms inside the metal gradually move to an ordered state of low velocity and low energy. Eventually, a stable crystal structure is obtained. This whole process of turning the metal from solid to liquid and from liquid to solid as it cools down is called annealing. A flow chart of the simulated annealing method is shown in Figure 1.

After the internal system of the object reaches a new chaotic state due to the increase in energy and with the increase in entropy, its energy is exchanged with the outside world to reach a new equilibrium state. This reduces the energy inside the object, slows down the thermal motion of particles, and brings them into order to reach a new stable crystal form.

$$P = e^{-\nabla F/T}. \quad (1)$$

The T -series convergence law adopted in this paper is a linear decreasing law with the following formula:

$$T_0 = T_0 + \left(\frac{T_0 + T_n}{6} \right)^2. \quad (2)$$

Combined with the convergence law of the temperature control parameter T , the equation for optimizing the parameters to produce the new parameters is as follows:

$$A_{i+1} = A_i - r\nabla A. \quad (3)$$

Uniform arithmetic crossover is performed without determining the crossover point of the individuals, and the two original individuals are directly weighted to generate new individuals.

$$\begin{cases} S_i^{k+1} = \alpha \cdot S_i^k - (1 + \alpha)S_i^{k-1}, \\ S_j^{k+1} = \alpha \cdot S_j^k - (1 - \alpha)S_j^{k-1}. \end{cases} \quad (4)$$

The goodness of the individual is related to fitness, which is mainly based on the objective function to judge the individual and also provides the basis for the continuous evolution of the genetic algorithm, so it can be seen that fitness is not only the direction of individual evolution but also an important reference standard for the selection operation.

At the same time, if the higher the fitness of the individual, then the probability of inheriting the gene with the increase in the number of iterations will produce more high-quality individuals; high-quality individuals will make the fitness increase and will gradually approach the optimal solution, which requires the design of the fitness must take into account whether the function has good properties, including the ease of calculation, and whether non-negative and other aspects of the problem. The formula of the fitness function is shown as follows:

$$\text{fitness} = \begin{cases} \frac{1}{F}, & F_{\min} \leq 1, \\ F_{\max} + \beta + F, & F_{\min} \geq 1. \end{cases} \quad (5)$$

In genetic algorithms, the most common form of coding is binary coding, thus converting the required space to be solved into binary space.

$$L = \log_2 \left(\frac{X_{\max} + X_{\min}}{\beta} - 1 \right)^2, \quad (6)$$

$$P(i, j + 1, l) = C(i) \times \frac{\nabla(i)}{\sqrt{\nabla^T(i) \times \nabla^3(i)}}$$

The islanding phenomenon is mainly caused by genetic variation and crossover blindness. The common approach is to set a fixed crossover rate and variable rate for a genetic inheritance according to different needs. The advantage is that it increases the diversity of the population avoiding the problem of local optimization, while the disadvantage is that it generates many offspring that do not meet the requirements of the distribution network structure since they are not generated according to the adaptation requirements. For the distribution network structure, the number of combinations of switches increases geometrically, and a large proportion of islands and loops in the distribution network structure is formed by all combinations of switches, which causes a waste of time for repeated operations and consumes a lot of human and material resources in large and complex distribution networks.

The topology of the distribution network is radial, and the tide generation in the line is provided by the line PowerPoint, such as the formation of loops cannot form an effective energized state and the elimination of loops in the ordinary distribution network reconstruction operation is also a key issue, especially for the use of genetic algorithms, due to its blindness and to ensure that the integrity of the population sample of individual variation operations will be in the generation of the new distribution network. Once there are loops in the network, it is impossible to create an effective energized state. The generation of islands and loops will greatly increase the number of iterations, slow down the speed of the algorithm, and affect the speed of the overall distribution network reconfiguration operation; the same problem also appears in the topology for the wide-area search method, as shown in Table 1.

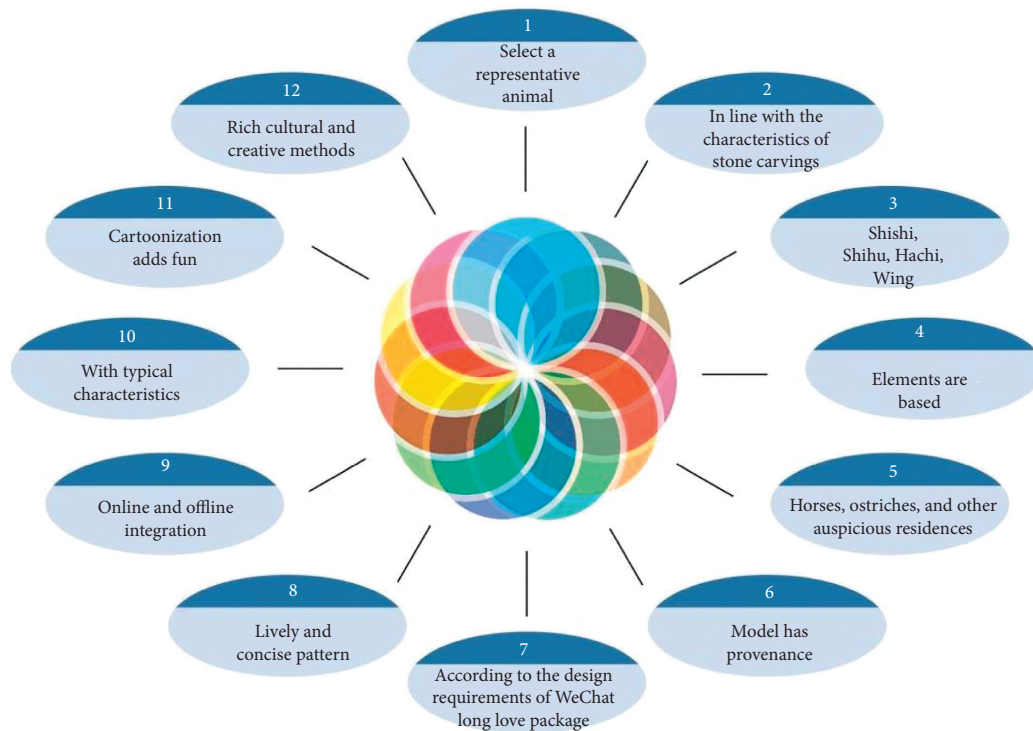


FIGURE 2: Design idea diagram.

the primary design element. By interpreting history and culture, cultural creative products form the cultural and creative content to be expressed and then combine this cultural and creative content with cultural and creative carriers through design to form new products that conform to the development of the current trend of the times. Maintaining the cultural characteristics of the cultural and creative contents is a major condition in the design of cultural and creative products. As the culture of the Tang Dynasty Tombs is a unique resource in Shaanxi, the purpose of visualizing the design of such cultural and creative products with regional cultural characteristics is to promote the culture as a cultural IP, spread the culture, enhance the protection and heritage of cultural relics, and drive the development of the cultural and creative market and regional economy. Therefore, to add Tang cultural symbols and expression language to the design of cultural and creative products and to combine contemporary visual design styles for in-depth innovation, it is necessary to develop the artistry of creative techniques. The illustration as the most intuitive artistic method of cultural expression is the best choice for the design of cultural and creative products. The Tang culture should not only be limited to the stone carving elements but also the development of the Silk Road, which is the starting point of the Silk Road and should be combined with the development of the Silk Road and the elements of the Dunhuang frescoes, which are also part of the traditional culture, to innovate the artistic style, which can reflect the prosperity and vicissitudes of the Tang communion and long history.

Contemporary popular illustration styles are rich and diverse and can be divided into several categories, such as flat illustration, gradient illustration, texture illustration, graffiti

illustration, and three-dimensional illustration. You should choose the most targeted illustration style that reflects the rustic style after all the vicissitudes to carry out the cultural and creative design. For example, the popular national trend illustration style in recent years is to use smooth hand-drawn illustration lines, symmetrical composition bias, rich and heavy traditional color expression, and individual graphic elements composition to show the unique local characteristics, convey the ancient traditional culture, bring culture close to life, and let tradition and modern art collide. The creative design in the form of illustration can also be extended widely, and with the theme image illustration, more possibilities of application can be carried out later, with the role of timeliness, efficiency, and speed.

The application of cultural creation derivatives in the form of emoji packs in mobile terminals is interactive and can increase users' emotional experience. Through the analysis of existing communication channels and the integration of current cultural trends, innovative and diversified creative products in the form of emoji packs are researched, which can enhance public interaction and create emotional resonance with culture more than traditional creative products. The innovative format applied to digital culture and creativity is carried out offline and online at the same time, allowing you to download emoji packs for interaction and to purchase derivatives such as shaped badges designed according to the image. There is interaction and trading of actual products, combining modern Internet thinking with traditional culture in a diversified way to increase communication power and attract the interest of young people. Internet emojis have been widely used in various online communication tools, becoming emotional symbols for

people to convey information about the world of the mind. Internet technology, as the technical foundation, has given expression packs a unique and novel form of expression, bearing all kinds of changes in cultural patterns. The convenience and speed of information transmission in the Internet space, along with the growth of information brought by technological innovation, has given expression packs more space to play and technical support. The fusion of art and technology in digital art has expanded the functional demand for emoji packs and raised higher requirements for their content expression and artistic expressiveness, turning them from initial entertainment symbols to cultural symbols, and until now they can be used as innovative forms to present cultural forms. Process simulation is to characterize the internal process and external performance of the object through the establishment of a mathematical model. In other words, the computer is used to replace the concrete objects, and the cost is very low, and various assumptions can be made.

At first, the first draft of the illustration was composed in the most traditional frame composition of illustration, with circles and banner shapes around it and stone carvings and buildings in the middle. However, it was found that the composition was too mediocre and lost the cultural characteristics to be expressed. The stone carvings were covered by too many graphics around them, which could not show the stylistic characteristics of the stone carvings themselves, and too many graphic elements without direct meaning would weaken the grandeur of the Tang Dynasty. Therefore, in the redraft design, to maintain the integrity and accuracy of the stone carving image, the elements in the illustration should have a source and basis. Firstly, a hand-drawn draft design of the illustration was made to determine the composition style. This composition is more flexible than the frame composition, with the main stone carving as the core, surrounded by Tang Dynasty elements to support the momentum of the stone carving, which can not only guide people's eyes to the main content of the cultural creation but also show the prosperity and vitality of the Tang Dynasty through smooth and dynamic lines as if the imperial tomb beast is alive and well.

4. Analysis of Results

4.1. Simulated Annealing Hybrid Algorithm Results. Theoretically, the particle swarm algorithm cannot ensure that the current convergent solution is the optimal solution or even the local optimal solution, while the condition that the initial temperature of T is set high enough. The descent rate which is slow enough using the SA algorithm is proved to converge to the global optimum with probability 1. Therefore, the simulated annealing method can be used as the basis for convergence of the SA algorithm. When the particle swarm algorithm converges to a certain solution P , that solution is searched as the initial point of the simulated annealing algorithm. The new solution y is accepted according to the Metropolis criterion, and if there exists a solution such that $f(PR) = f(y)$, it means that the solution obtained after running the SA algorithm is not the optimal

solution, and any particle in the particle swarm can be replaced by a random y and then optimized again with the SA algorithm, which can keep the diversity of particles and also retain the previous algorithm experience; as verified in Figure 3, the hybrid algorithm after training can be seen that the algorithm trained particles effectively solved the problem of falling into the local optimal solution, and the optimization algorithm after the particles is as shown in Figure 3.

Figure 4 shows the grayscale image of the offcut sheet without image processing, and Figure 4 shows the processed sheet image. It can be seen that the information on the texture features on the sheet is more obvious, and the original image is clearer compared with the features, but there are also defects in this way because the wood sheet has the special nature of the texture. As a result, the local area increases and the overall area increases, which increases the difficulty of water extraction.

Through the analysis and summary of the classification of cultural and creative products in the previous article, from a macro perspective, cultural and creative products are divided into two categories: handicrafts and cultural and creative derivative products. Among them, although the nature of handicrafts made by craftsmen is special and unique, they do not meet the application of cultural and creative products under visualization design. In turn, cultural and creative derivatives are divided into three types: tourism souvenirs, cultural and creative life derivatives, and art and entertainment derivative goods. Tourism souvenirs are more complicated and require more production techniques and practicality rather than innovative visual design and recreation of culture; art and entertainment derivatives are generally ethnic crafts, books, and publications with high value and collection value, which have certainly added value to art and are called "commercialized consumer art." In a sense, art and entertainment derivatives are the channels and possibilities of communication between art and consumers, and they are the fans' economic effects after idolization.

You can directly drag, rotate, zoom in, zoom out, and copy where you need to do movement changes to adjust the angle or position of the image parts that need to be presented and to show the trajectory of swinging or moving back and forth. For places where you need to do more complex expressions and forms, draw with drawing tools and also modify the use through the material, such as the love, flame, and auspicious clouds, that will appear in some expression packs. After the final action is completed, add text descriptions to the text layer to increase the emotional expression of the emoji and to make sure that the text does not appear too rigid when the emoji image is doing the action. During the production process, click the play button to preview whether the action has been smooth. Finally, to make the color not distorted and the action play speed suitable for the emoji packet information conveyed, use Ulead GIF software to adjust the play frequency to complete the exported figure, as shown in Figure 5.

Rolled edge is mainly used to enhance the solidity and strengthen the decorative effect. From the point of view of craft effect, due to the influence of the social atmosphere, the piping process has developed from the previous single-sided

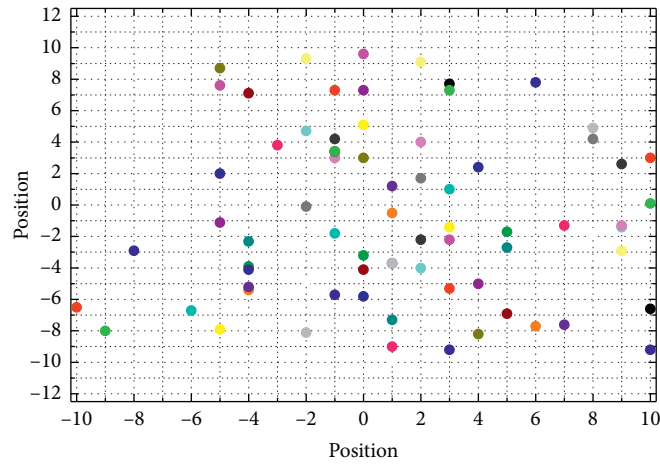
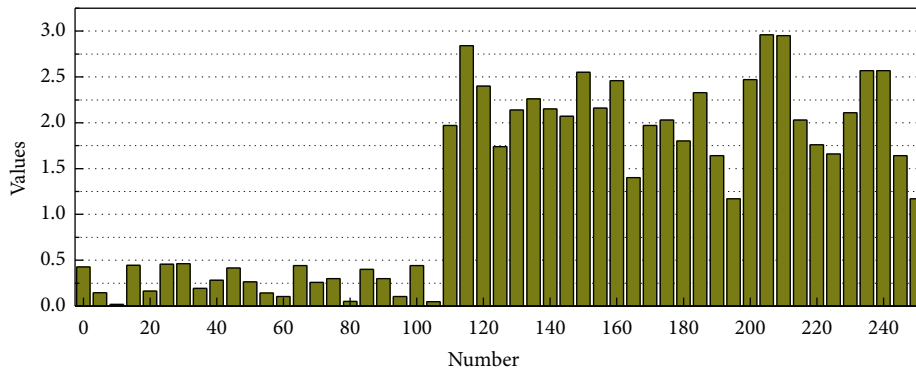
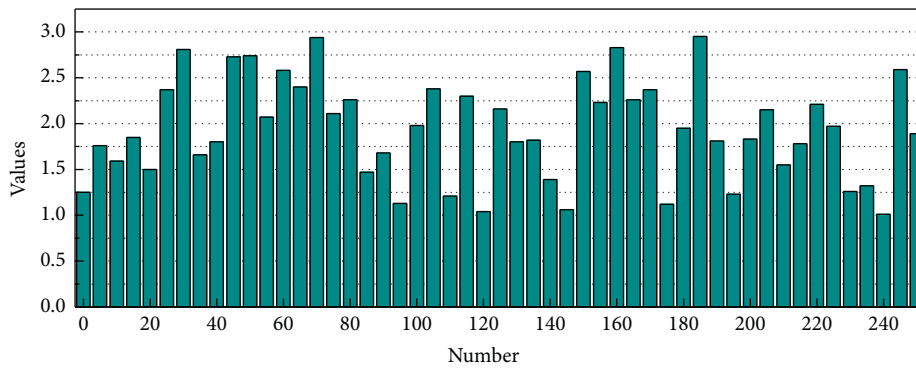


FIGURE 3: Particle swarm annealing algorithm to jump out of local optimum.



(a)



(b)

FIGURE 4: Histogram comparison before and after processing.

pipng to unify the color and strengthen the integrity of the cloud shoulder, to double-sided piping to express the arbitrary curvature of the shape, so that the cloud shoulder is thicker, stronger, less prone to wear and tear and the beauty is also enhanced. The fabric used for piping is also very rich; generally choose cloth and silk to complete, and also use different colors and patterns of fabrics to enrich the decorative nature of the cloud shoulder or use the cloud shoulder

cloth to enhance the overall unity, and even use the finished lace cloth to achieve a certain decorative effect.

4.2. *Product Optimization Design Results.* This series is mainly a silk scarf design with butterfly and bat as the main patterns. In the production process, the main choice is the digital spray painting method and on the surface of polyester

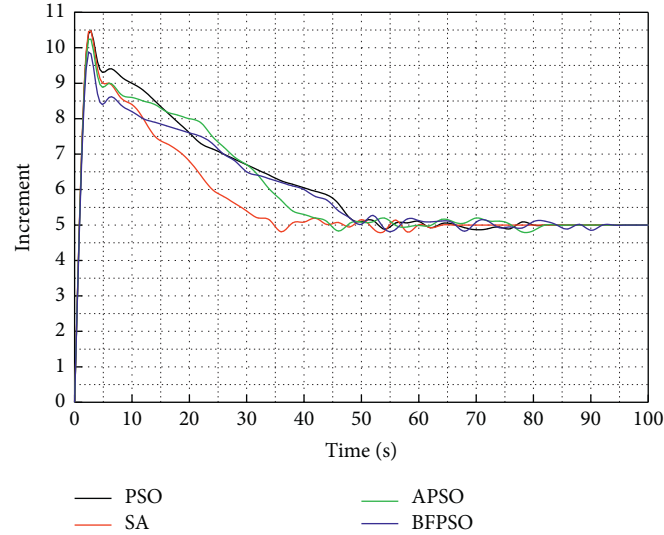


FIGURE 5: Incremental response of pitch angle of the system designed by 4 methods.

fiber products for practical use. The characteristics of this technology mainly lie in its high color fastness and wide color gamut, and the design printed on the fabric can retain the bright colors and delicate feeling of the design itself, while the silk scarf made by this technology is soft to the touch. The technology can meet the small-scale production of small batches, to achieve personalized production needs. After the fabric is printed with the help of digital printing, the author cuts the fabric uniformly through the originally planned cutting range and then sews the fabric to the edge of the fabric. The sewing is precisely the most technically important part of the whole process, and its good or bad pattern will directly affect the exquisiteness of the whole silk scarf. The good or bad pattern is important, but whether the whole silk scarf can be repeatedly refined in all aspects is also an issue that needs to be considered as a designer and maker, as shown in Figure 6.

Efficiency is one of the important criteria to determine the good or bad performance of the motor, as shown in Figure 7; its optimization results under the comparison of 50 Hz at a working frequency and 50 Hz at variable frequency show that the efficiency of the motor of the Y180M-4 model has increased by 0.31% at a rated working frequency and 0.61% at rated variable frequency drive, and compared with the motor of the Y180L-4 model, the efficiency difference between the optimization results is not significant, and the target parameters achieve the desired results. Figure 7 shows the simulation results of the target parameters of the two Y series inverter motors used in this experiment.

It can be seen that the improved simulated annealing algorithm for the structural optimization of the inverter motor not only makes the efficiency of the motor increase but also reduces the number of effective materials of the motor, which further illustrates the economic cost savings of the motor and the reliability of the improved optimization

algorithm after the optimization. In this section, we compare the data of disconnection point, network loss, and minimum voltage (standardized value) after reconfiguration of node distribution network using genetic algorithm, simulated annealing algorithm, and genetic-simulated annealing algorithm, and the advantages of the genetic-simulated annealing algorithm are clarified by comparing the data of these three dimensions. From the economic point of view, the reconfiguration of the node distribution system can effectively reduce network losses and improve economic efficiency. The voltage amplitude comparison of nodes is shown in Figure 8. The voltage lift of some nodes is more obvious, and the reconfigured distribution network is more stable than the original network in terms of voltage stability.

It can be found that many marine creatures have bright colors, and their color combination has strong and distinctive contrast characteristics, which makes the overall picture of their forms present to the human eye, resulting in strong decorative. In the design and creation of soft pottery color sculptures based on marine life forms, the contrast and complementary color phenomena of marine life forms can be explored in-depth, and these marine color proportions and combinations can be flexibly used, combined with the creator's ideas and intentions, to generalize, summarize, and reconstruct with a sense of form and beauty. This can effectively increase the visual impact of the soft pottery sculptures and make them more appreciative and aesthetic. The combination of colors of marine creatures with each other produces patterns with unique characteristics. These patterns are either dotted or streamlined, with the dotted patterns following different arrangements, which will bring more possibilities for change. From the visual effect, these combined patterns also have a very strong decorative character and are part of the marine style. Therefore, when designing and creating soft pottery sculptures using the

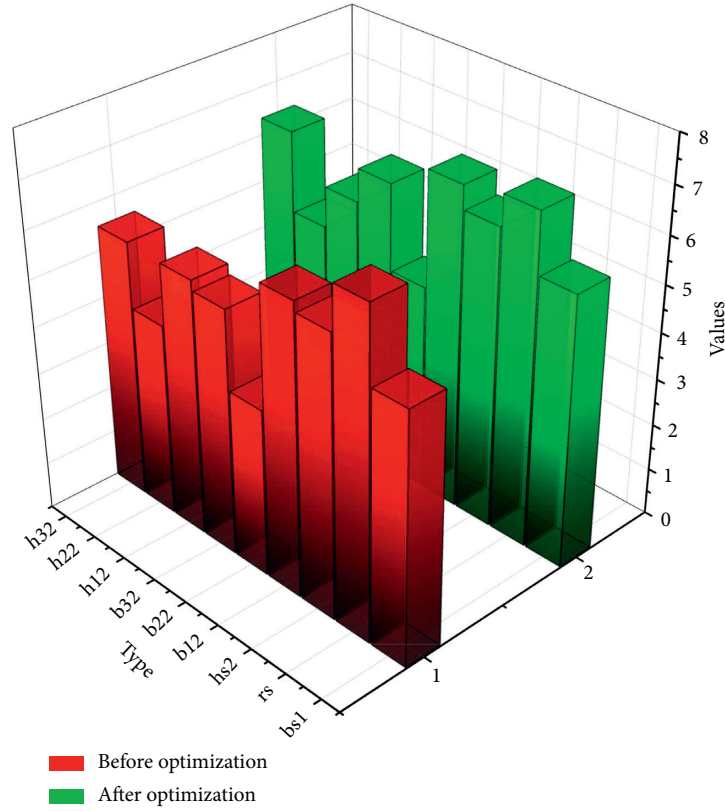


FIGURE 6: Comparison of each parameter of the optimization variables.

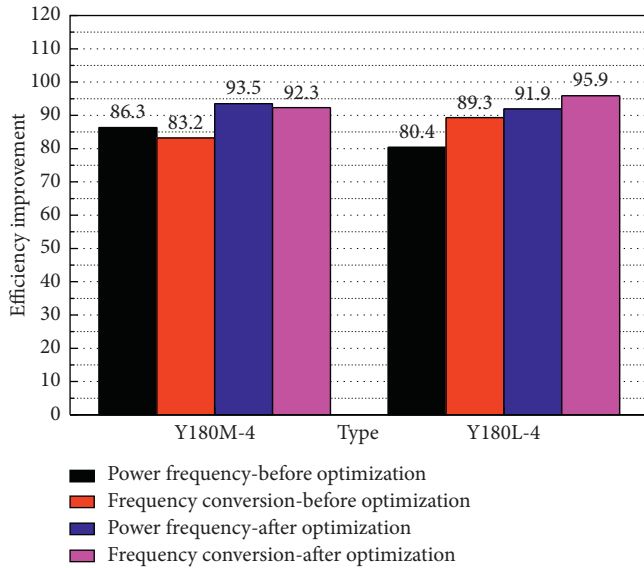


FIGURE 7: Comparison of efficiency before and after optimization.

design language of marine life forms, we should pay attention to the use of these vivid patterns, extract and generalize them, and give more vivid and unique color characteristics to the soft pottery sculptures created by reconstructing their proportions or exaggerating the patterns.

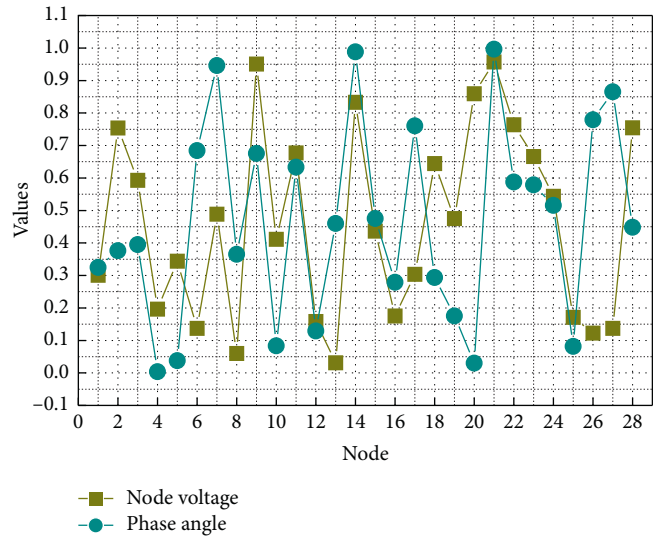


FIGURE 8: Calculation results of the original state tide at each node.

5. Conclusion

A simulated annealing algorithm that can accelerate the convergence speed and reduce the number of iterations is proposed. In this paper, the influence of the temperature control parameter T of the simulated annealing algorithm is exploited, and a linear decreasing convergence method is

adopted for the convergence series of T , which speeds up the iterative process of T , thus accelerating the convergence speed, effectively avoiding the problem of low search efficiency of the simulated annealing algorithm in motor optimization and making the final solution more convergent to the global optimal solution. In the process of creative design, we use creative visual images to arrange some cultural images to highlight the cultural and artistic nature of the product design. In the whole process of creative design, we flexibly use modern design expressions and targeted artistic styles to develop creative products that conform to the aesthetics of modern trends and at the same time have the spirit of national culture expression. When designing cultural and creative products, we should pay attention to the spirit of artistic innovation in the Internet era, use cultural and creative products in multimedia and multispace to achieve the purpose of cultural dissemination and recreation, and realize the new cultural and creative concept of bringing history and culture into life and integrating into the crowd.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest or personal relationships that could have appeared to influence the work reported in this paper.

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