Hindawi
Mobile Information Systems
Volume 2022, Article ID 5823849, 8 pages
https://doi.org/10.1155/2022/5823849

Research Article

Designing Decorative Flower Patterns for Clothing Using Genetic Algorithm

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Received 27 May 2022; Revised 30 June 2022; Accepted 16 July 2022; Published 17 August 2022

Academic Editor: Muhammad Babar

This paper aims to incorporate artistic vocabulary from intangible cultural heritage into historical clothing designs, particularly beautiful pattern designs. It is based on a profound understanding of the concept of immaterial cultural heritage and the mastery of its traditional skills to meet the public's needs in terms of clothing and flowers. Technology, culture, and intangible cultural legacies can all be passed down and incorporated into the design. It is using interactive evolutionary computing to investigate the intangible cultural heritage elements of designing novel decorative flower patterns for clothing. Due to the rapid advancement of digital technology, computers are now used more frequently in the design of patterns and clothing. The goal is to improve the production of artistic trends and decrease the use of manual and traditional methods. This study uses interactive genetic algorithms to examine the current state of intangible cultural heritage elements in building designs for decorative flower patterns for clothing. The application of genetic algorithms to the design of clothing with flowers as decorative patterns is the main focus of this paper. The genetic algorithm is described, followed by an analysis of its fundamental structure. Then, the characteristics of the clothing flower decorative pattern are determined, the genetic algorithm model is applied to the design of the decorative flower patterns for clothing, and the hierarchical structure of heredity, variation, and interaction is provided. Finally, the genetic algorithm is applied to the large-scale generation and mutation optimization of designing decorative flower patterns for clothing after analyzing its application in clothing flower decorative pattern technology. The idea presented in this paper can self-reproduce and optimize, resulting in the nonartificial generation and optimization of designing decorative flower patterns for clothing.

1. Introduction

The clothing industry has long been regarded as a vital representation of human civilization, and it still uses contemporary technology to compete. The social culture of the society in which people live is reflected in their fashion choices. According to studies, the way people dress is an extremely effective way to boost their confidence and belief [1]. People in society utilize their dress as a means of exhibiting or confirming their social standing. The employment of ideal techniques in clothing design, clothing production, and sales is crucial nowadays due to the value of clothing in societies and growing market competitiveness. Since the fabric design business has an impact on fashion design, fabric pattern sets may be utilized to create uniformly styled clothing as well as a variety of looks to appeal to a broad range of consumers [2]. These clothing designs may satisfy a wide range of customer desires because they are created by combining various forms, colors, graphics, and many other visual aspects. Among the aspects are the promotion of psychological influences on a person's personality, satisfaction of individual preferences, concealment of physical flaws, enhancement of the depiction of certain bodily attributes, and the design of visually appealing clothing representations. Furthermore, substituting different representations of a cloth set for various cuts and decorations reduces manufacturing costs while increasing product sales. Before making a strategy, build producers and consumers can poll customers about their preferred clothing styles and color schemes and incorporate their feedback into the design process. There is a lot of interest nowadays in the use of computer design software in clothing, specifically in the field of clothing design. The genetic algorithm is one of the algorithms used in fashion design, and it has been extensively used in computer design systems to support design [3, 4].

People's living standards have gradually improved as the method of economic development has changed dramatically. People tend to embrace nonhomogeneous and personalized aesthetic standards when it comes to clothing patterns, which requires clothing pattern designers to make their works more personalized on the one hand while meeting people's various needs on the other [5, 6]. A genetic algorithm is a kind of randomized search method that evolved from the evolution law of biology [7]. The ability of organisms to survive and reproduce in nature demonstrates their ability to adapt to their environment. It motivates people to conduct mechanism analyses and social simulations of various population features of creatures, which opens up a wide range of possibilities for the development of artificial adaptive systems [8]. The use of genetic algorithms represents a significant advancement in the computational methods of biological phenomena [9]. The genetic algorithm generates numerous artificial systems with high adaptation and optimization capabilities based on computer simulations of biological genetics and the evolution process [10]. The significance of incorporating artistic terminology of intangible cultural heritage into historic clothing designs, especially beautiful pattern designs, is the growth of the clothing design business.

The artistic design of ethnic clothing within the context of artificial intelligence has received considerable attention in the literature. For example, the Internet of Things and influential Chinese designers are committed to fusing ethnic costume culture with contemporary clothing design and basing their ethnic costume designs on national culture. In their study of the integration of fashion design and an intelligent algorithm, Zhu et al. proposed an interactive clothing design approach and a personalized virtual display system that makes use of users' real faces. They investigated a genetic engineering-based fashion design approach, using suits as an example of consumer contact. Customers can thus rearrange the fashion components of their clothing, choose from a variety of colors and fabrics, and present their unique suit style. Researchers created a web-based 3D personalization proposed framework for personalized clothing around the same time utilizing unity 3D and VR technology. The system provides the structure and function architecture when integrated with the data flow diagram. The model organization testing illustrates that, while it can effectively display the impact of garment textiles and provide customers with a personalized visual experience, the technology is unreliable [11]. Yamashita et al. presented a color matching approach that takes into account the intensity difference and design features of neighboring sections. To provide the ideal color scheme for ordinary people, their algorithm also distributes color information between instances of a color combination. The authors used interactive evolutionary computing to build the brightness and hue, distributing the components suitably to each area depending on human perception. Even before specifying the color component, they initially designed the luminance while maintaining brightness. The color scheme was gorgeous and harmonized as a result of their selection of premium color combination patterns. The system's excellent performance is confirmed by computer simulation, but even so, their approach is impractical [12]. Yen et al. made an important contribution to the evolution and advancement of the local tin culture manufacturing by taking cultural heritage as a starting point, extracting significant cultural image components from traditional handicrafts and tinware, and incorporating them into product design through knowledge integration. The authors proposed a framework for investigating cultural product design. Material culture on the outside, behavioral culture in the center, and intangible culture on the inside are the three types of culture. These three strata comprise the cultural space. Despite offering a novel perspective on cultural design research, this division's methodology falls short [13].

While traditional optimization algorithms frequently determine the actual planting of decision variables directly, a genetic algorithm uses the code of decision variables as the operation object. The genetic algorithm is implemented with a standardized set of decision variables, enabling us to conveniently apply genetic operators while also learning about chromosomes and genes from biology and replicating their genetic and evolutionary processes [14, 15]. In particular, a new trend in machine learning based on genetic algorithms in the study of genetic algorithms has emerged in recent years. The genetic algorithm is being extended in this new study area from a discrete search space optimization search algorithm to a brand-new machine learning algorithm with a specific rule-generating function [16, 17]. The bottleneck issues in acquiring knowledge, optimization, and improvement in artificial intelligence may be solved with the help of this novel learning process. This paper is used to create a clothing flower decorative pattern. The traditional clothing flower decorative pattern design is combined with genetic algorithms through the use of genetic crossover and mutation operations. So that clothing flower decorative pattern design can be automated, convenient, and optimized, clothing flower decorative pattern design can be made simpler and more flexible, and the burden on clothing flower decorative pattern designers can be reduced.

The following are the main contributions of this paper:

(i) Firstly, this study discusses the significance of intangible cultural heritage elements in clothing flower decorative pattern creation using interactive genetic algorithms.

(ii) Secondly, this paper is used to make a flower pattern for clothing. Through the use of genetic crossover and mutation operations, the traditional clothing flower decorative pattern design is combined with genetic algorithms.

(iii) Thirdly, an analysis of the basic structure of the genetic algorithm follows a description of the genetic algorithm. After determining the characteristics of the clothing flower decorative pattern, the hierarchical structure of the genetic algorithm model is applied to the design of the clothing flower decorative pattern.

(iv) Finally, the analysis of the genetic algorithm's use in clothing flower decorative pattern technology is preceded by application to the large-scale generation and mutation optimization of these patterns.

The remaining sections of the paper are logically arranged as follows: Section 2 presents related work, Section 3 presents the genetic algorithm, and Section 4 presents algorithm simulation. Finally, the research work is concluded in Section 5.

2. Related Work

The fitness function inside the genetic algorithm determines the fitness level of individuals in each generation. However, certain issues are impossible or challenging to analyze since they can only be determined by the human intellect and cannot be quantified using a scale. The interactive genetic algorithm, in which a human evaluation takes the role of the fitness function, was developed to address this issue. Interaction between humans and robots using genetic algorithms has helped to alleviate some of these problems. The advantage of the method is that individuals only need to be aware of the output assessment; complexity is not required. The expression of the fitness degree is the only difference between the interactive genetic algorithm. Therefore, problems in the arts and design that genetic algorithms find complex can always be addressed using an interactive genetic algorithm [4]. The genetic algorithm, also characterized as the optimization algorithm, is an optimization method that draws inspiration from the behavior of living things. It is used to solve optimization issues across a variety of sectors [18]. Sano et al. proposed a three-dimensional computer-aided fashion design system that could simulate Japanese Yukata clothes and determine the buyer's body type. Direct manipulation can be used to incorporate user preferences during product development and avoid user fatigue [19]. Volino et al. established a framework and specifics that meet the needs of the clothing industry in order to build virtual apparel and models with an emphasis on interactive design, visualization characteristics, and simulation. This is an evolution tool for implementing best practices in fashion modeling and advertising design processes, as well as animations and mechanical simulations [20]. Gong et al. proposed a revolutionary procedure based on a multipopulation strategy and change strategy that may improve population diversity, prevent selecting for the fittest generation, and decrease employer fatigue [21]. Ogata et al. demonstrated a fashion design assistance system that incorporates an interactive evolutionary algorithm and solicits user feedback. The process generates designs, displays selected models to the user for review and then improves on those designs using the genetic algorithm's selecting, crossover, and evolution operations [21].

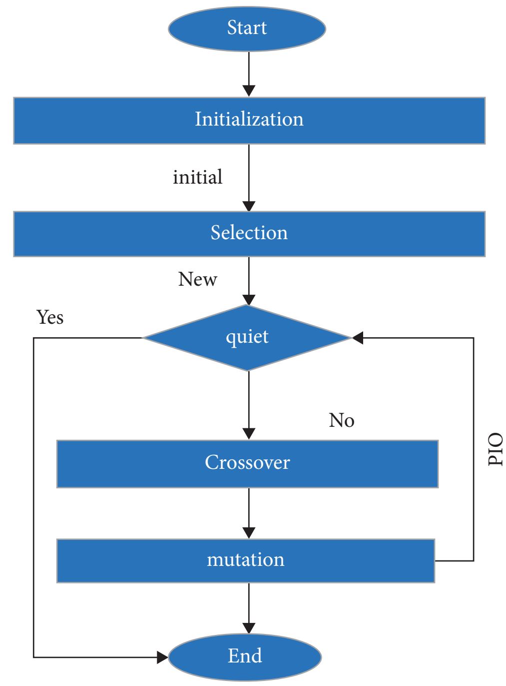

Figure 1: The genetic algorithm framework.

3. Genetic Algorithm

3.1. Basic Framework. The genetic algorithm used in this paper is an algorithm with the characteristics of generation and verification. The sample image coding population is used as the genetic basis, the fitness function as the evaluation basis, and the genetic mechanism is realized by the genetic operation of the stored image data bits. The database establishes an iterative process, selecting individuals for each generation of the population according to the fitness of individuals in the problem domain. It uses genetic operators, such as the hybridization operator and mutation operator to act. Thus, the next-generation population representing the new solution set is generated [22]. The basic framework of the genetic algorithm is shown in Figure 1.

In the whole genetic process, genetic algorithms operate at random. It may effectively make assumptions about the merit-seeking group given the better expected performance of the upcoming generation using previous data. In selecting the most appropriate solution to the problem, this continued inheritance from generation to generation ultimately converges on the person who is most suited for the environment. The genetic algorithm works in the following prescribed sequence:

(1) Read the selected clothing flower decorative pattern data and generate the initial population as $p(0) = \{x_1^0, x_2^0, \ldots, x_N^0\}$. Let us encode each individual to obtain the corresponding point called a chromosome or string. This paper adopts binary coding.

(2) Calculate the fitness of each individual in x_i^0.

(3) Using the hybridization operator to create the offspring, the mutation operator to create a new

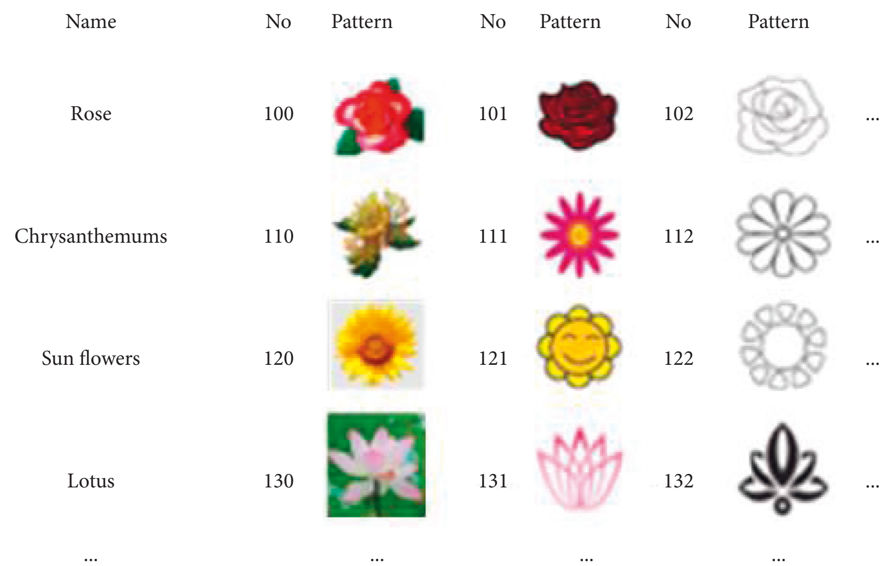

Figure 2: Evolution diagram of clothing flower decorative.

offspring set o, and the random principle, choose one of the subpopulations as the parents of the offspring. The fitness of each individual in o is then calculated.

(4) The next-generation population is selected from or by the selection operator. Let $t = t + 1$.

(5) If the suspension condition is true, it will stop. Otherwise, turn to (2).

3.2. Designing Flower Decorative Pattern Features of Clothing. With the improvement of production technology, the performance of designing decorative flower patterns for clothing is more diversified, and combined with many art forms, it brings newer visual beauty [23]. This paper summarizes the morphological evolution of designing decorative flower patterns for clothing and classifies them according to the pattern content, which can be divided into roses, chrysanthemums, sunflowers, lotus flowers, and so on, as shown in Figure 2.

The distribution of clothing and flower decorative patterns presents a modular distribution state. Applying the clothing flower decorative pattern to specific different modules according to the abovementioned law, a series of patterns in line with this law can be designed [24]. This is similar to the modular idea of an interactive genetic algorithm. Therefore, the pattern combination of real estate flowers can be used to produce a large number of interactive patterns designs according to the pattern combination of real estate flowers.

3.3. The Design Processes. In this paper, the following process is adopted for the design process of designing decorative flower patterns for clothing based on a genetic algorithm.

3.3.1. Read the Selected Clothing Flower Decorative Pattern Data. Generate the initial population $p(0) = \{x_1^0, x_2^0, \ldots, x_N^0\}$. Let $t = 0$, and binary code each individual in $x_i^0\,(i \in [1, N])$. Keyword vector: $c = (c_1, c_2, \ldots, c_n)$, $c = (w_1, w_2, \ldots, w_n)$. The keyword ID is a weight and the value is a floating-point number. It is the main data structure of operation in genetic algorithms. When encoding, the vector is constructed according to the descending order of the average weight of keywords. So, most of the keywords of high weight are placed in the front of the vector, which means they are not easily destroyed in the crossover operation, which is conducive to the rapid convergence of the algorithm.

3.3.2. Genetic Manipulation of the Initial Population. The goal of selection is to select one individual to be copied from among others; in general, fitness is used to make the selection. Individuals with high fitness levels are more likely to be chosen in order to ensure that exceptional individuals can enter the next generation. The genetic algorithm reflects the natural selection principle of survival of the fittest [25]. Through the selection of individuals with high adaptability, we can choose the design shape suitable for people's aesthetic outlook. Then, further optimization is carried out through other genetic variation operations.

The genetic algorithm produces crossover because it is the fundamental operation for obtaining a good algorithm solution and the starting point for population evolution. Crossover is the process of combining some of the traits (genes) of two people to produce novel people. The intersection point, which may have one or more intersections, must be specified before beginning the crossover operation process [26]. This paper adopts multipoint intersections. The algorithm generates a breakpoint in the pixel array of one clothing flower decorative individual, and the pixel data after the breakpoint is exchanged with the data after the breakpoint of the pixel array of another clothing flower decorative individual.

Variation selects a gene on the chromosome according to a certain variation rate p_m and then changes the characteristics of the gene. Variation can not only ensure the introduction of useful genetic material and maintain the diversity of populations, but also appropriately improve the search efficiency of GA [27]. In this paper, when the object encoded by a floating-point number realizes the mutation operation, the boundary is recorded in the pixel array, and then the boundary data is reencoded by the floating-point number, and the data in the new pixel array is extended according to the rules.

3.3.3. Selecting Sample Patterns by the Fitness Function. The fitness function is a standard used to determine whether or not members of a population should be eliminated. It also appears to satisfy the need for object optimization. The primary goal of optimization in this algorithm is to obtain crafts suitable for conventional aesthetic appeal. As a result, the fitness function can be simply expressed as the average value of the correlation between a keyword vector and several training samples [28]. The average value formula is

$$F_i = \frac{1}{m} \sum_{j=1}^{m} \operatorname{sim}\left(W_i, D_j\right). \quad (1)$$

The formula represents the fitness of the individual. i represents the keyword vector (individual) in the population. F refers to the first training document, with a total of m.

4. Algorithm Simulation

4.1. Genetic Operator Parameter Setting. In order to ensure the search designing decorative flower patterns for clothing throughout the database, the parameters involved in the interactive design of designing decorative flower patterns for clothing in this paper are hybridization probability and mutation probability. The hybridization rate determines whether two individuals will hybridize and the hybridization method. If the hybridization rate is set too high, the algorithm will produce random hybridization, which will destroy the better model. The population is going through a genetic process, which is starting to cause more problems with population evolution and offspring production. So, the speed of generating new individuals will slow down and aggravate user fatigue if it is too small, and the convergence of the algorithm is too slow [29]. According to the previous research on parameter setting of interactive genetic algorithms, the hybridization rate is usually set at 0.4 to 0.99. Because the individual pattern design results of clothing flower decorations are the main body of each other, the hybridization rate is set to 0.5 in this paper. Although the mutation operator is not the main force generating new individuals, if the mutation rate is too large, it can generate more new individuals. But it may destroy many excellent evolutionary patterns and make the interactive genetic algorithm operate in a way similar to the random search algorithm. So, to reduce the generation of new individuals, if the mutation rate is too small, although it can maintain the stability of the algorithm, the ability to suppress premature will become worse. In this way, the algorithm may terminate the iteration because it cannot produce the optimal solution.

4.2. Algorithm Variation Process. The relationship between the transformation of two vertical and horizontal positions is independent of random variation. In each transformation, gene segments are exchanged in the vertical and horizontal positions, which increases the diversity of genes and makes the speed of obtaining a satisfactory matching scheme faster. By summarizing a large number of design schemes generated by this pattern design program in the early stage, this paper takes the position of variation probability within $0.0001, 1$ and discusses the relationship between the aesthetic degree of the generated pattern design scheme. The variation probability value range and tries to analyze the variation probability value range. The algorithm generates more consistently with the general layout of traditional designing decorative flower patterns for clothing.

When the mutation probability is $P_m \in [0.0001, 0.01]$, the algorithm is prone to premature convergence. When the evolution parameter of the program is 0.01, it has reached the termination condition in the 20th generation and stopped evolution. Within the range of this parameter, although the matching scheme of designing decorative flower patterns for clothing has certain aesthetics, it is disorderly in layout and arrangement, and there is no rhythmic beauty and orderly beauty to traditional designing decorative flower patterns for clothing.

When the variation probability is $P_m \in (0.01, 0.1]$, the variation probability can be set to $(0.01, 0.1]$. The position relationship of clothing flower decorative pattern is based on the local pattern effect generated by the program, as shown in Figure 3.

In Figure 3, according to the pattern type, it can be divided into two probability intervals for discussion.

When used, the algorithm generates a rough plan layout form for the matching scheme for clothing, flowers, and decorative items, (100) and (110) as shown in Figure 3. The horizontal coordinates of the left edge of the clothing flower decorative pattern are the same, and the two are “tiled” and arranged compactly in the longitudinal direction. There is neither overlap nor space for an obvious distance. When $P_m \in (0.05, 0.1]$, the plane layout form of the generated clothing flower decorative matching scheme is rough as shown in (120) and (130) in Figure 3. The clothing flower decorative pattern takes the fixed point in the lower-left corner as the origin and expands in the same direction on the same coordinate axis within the probability range. The presentation of the formed clothing flower decorative pattern depends on the “superposition” pattern of some lines or colors at the same time. When the decorative patterns of clothing and flowers coincide, some patterns need to be abandoned to avoid the overlap and occlusion of patterns. The algorithm is established so that the color and outline of the clothing flower decorative pattern are maintained. As a

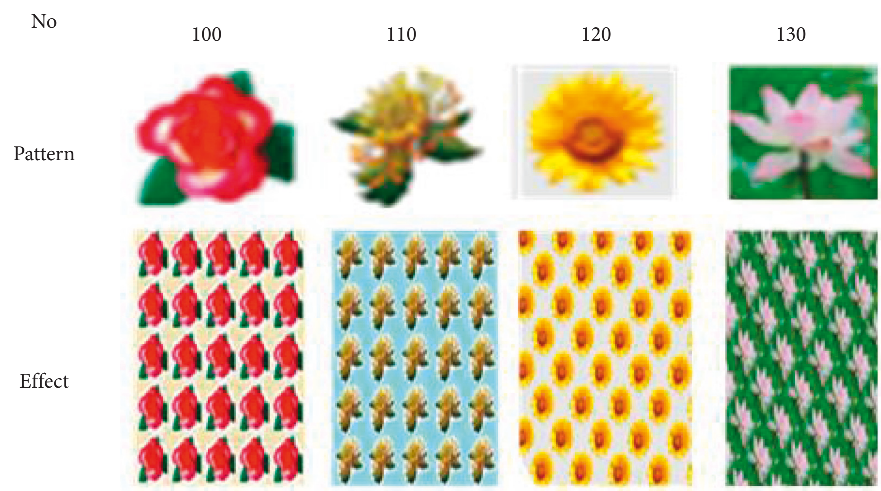

Figure 3: Comparison of pattern effect when variation probability $P_m \in (0.01, 0.1)$.

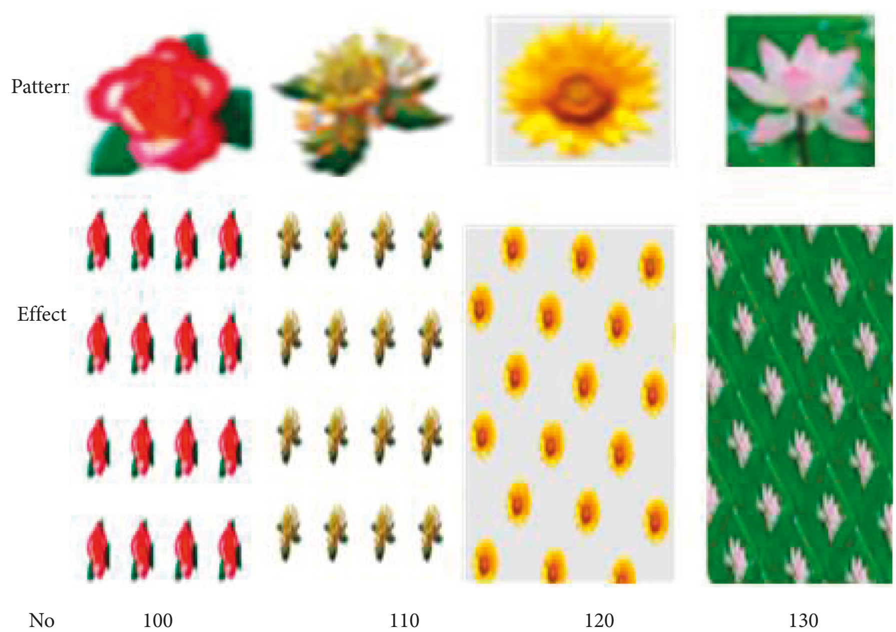

Figure 4: Effect comparison of clothing flower decorative pattern generated by the algorithm in the variation parameter range $P_m \in (0.01, 0.05]$.

result, the designer clothing flower decorative pattern is more integrated, less rigid, and generates an aesthetic feeling.

4.3. Algorithm Interaction Effect. The patterns obtained through interaction can be divided into the following two types:

(1) Effect of clothing flower decorative pattern generated by $P_m \in (0.01, 0.05)$:

Figure 4 shows the pattern effect. The generated designing decorative flower patterns for clothing are mostly parallel and tiled, taking up a specific amount of space on the plane. There are no shared characteristics between line and color. This pattern type is more consistent with the "mutual independence" distribution law in the distribution law of designing decorative flower patterns for clothing.

(2) Effect of clothing flower decorative pattern generated by $P_m \in (0.05, 0.1)$:

At this time, there is a certain dependence on the location and color layout form of the clothing flower decorative pattern. In this kind of pattern, the clothing flower decorative pattern is nested, superimposed, and interdependent, and together form a complete visual effect. This kind of scheme

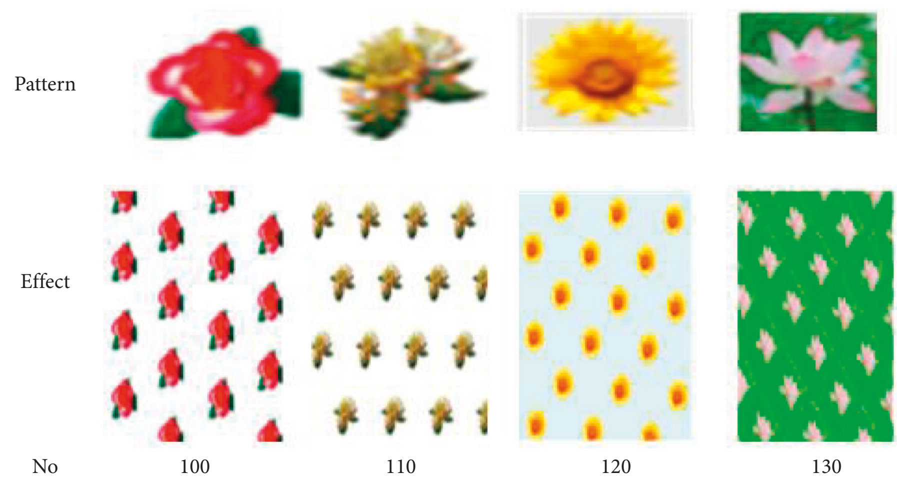

FIGURE 5: Effect comparison of clothing flower decorative pattern generated by the algorithm in the variation parameter range $P_m \in (0.05, 0.1]$.

is more in line with the positional relationship of "interdependence" in the clothing flower decorative pattern, as shown in Figure 5.

(3) Effect of clothing flower decorative pattern generated by $P_m \in (0.1, 1]$:

Although there will be an increase in the number of new clothing flower decorative pattern effects, the algorithm cannot converge effectively. So, the performance of the genetic algorithm is similar to that of the random search algorithm. After 19 generations of evolution, the result of the algorithm is still in a relatively intact state, but after 20 generations. The arrangement of the positions of the same pattern begins to appear in intergenerational chaos, and the generated matching scheme presents a phenomenon of overall disorder.

In summary, when the lateral displacement interval of the clothing flower decorative pattern is $[-20, 20]$, the longitudinal displacement interval is $[-15, 15]$, and the variation probability is $P_m \in (0.01, 0.1]$, the matching scheme generated by the interactive design program of the clothing flower decorative pattern has some characteristics of the traditional clothing flower decorative pattern; that is, it is similar to the mutual independence and interdependence.

5. Conclusion

Considering the inefficiencies of manual and traditional clothing design in the modern world, such as decreased speed and precision, increased cost, trial and error, and increasing rivalry in the clothing industry, the need to cut costs becomes obvious. By achieving a variety of consumer needs, digital technology can help this sector grow. This paper mainly studies the use of the genetic algorithm in designing decorative flower patterns for clothing. To effectively carry out automatic analysis of designing decorative flower patterns for clothing, randomly generate a variety of designing decorative flower patterns for clothing for genetic variation. However, to automatically screen and analyze a large number of designing decorative flower patterns for clothing and select decorative flower patterns for clothing, however, as to obtain a series of relevant patterns, select the decorative flower patterns suitable for clothing for the final selection. However, the research presented in this paper has not yet involved the color matching design of single pattern elements. It only starts from the layout of designing decorative flower patterns for clothing and obtains different aesthetic feelings by changing the positional relationship. The color in the pattern generated by the experiment is still the color of the pattern element itself when extracted. Although some pattern design schemes have not achieved satisfactory results in layout, they can still make up for some defects in the beauty of location and layout through the change of color matching. Therefore, in the following research, we can introduce color elements into the sample space to make the generated pattern design schemes more diverse, further expand the function of the whole design program, and have more practical value.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The author declares that there are no conflicts of interest regarding the publication of this paper.

Acknowledgments

This paper was supported by Research on the Practical Teaching of Art Design Based on the "Ternary Integration" of Technology, Science, and Technology and Creativity (no. Hnjg2021-102).

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