

Innovations in Eco-Friendly Fashion Clothing Design Based on SIFT Algorithm and Biomimetic Materials

Panlei Chen^a

^aLuoyang Xinghan Culture and Media Co., LTD., Luoyang, Henan, 471000, China

Abstract. In this paper, the SIFT algorithm is firstly used to obtain the feature vector and scale space of biomimetic materials by adopting a hierarchical approach, and then the BBF algorithm searches for the Euclidean distance between each feature point, which is matched according to the similarity criterion. Finally, the affiliation function is used to guide the integration of biomimetic elements to realize the innovative design of environmentally friendly fashion clothing. The results show that the garments designed based on bionic materials have less than 50mg/L effluent discharge, and the passing rate of children's clothing testing is over 80%. The sales volume can reach up to 1.45 million pieces per year. This paper integrates biomimetic materials and clothing design, that is, to meet the concept of environmental protection but also to meet the needs of the public aesthetic.

1. Introduction

The premise of rapid economic development is often a large amount of exploitation of the earth's resources and long-term consumption; such uncontrolled use of resources has led to a number of environmental problems and has been a serious threat to people's production and life, but also let people realize that one-sided development of the economy is wrong and the urgency of environmental protection [1, 2]. At present, the clothing design of the art of transformation means continues to develop because clothing design belongs to the category of arts and crafts and is a practical and artistic combination of a form of art, clothing design gradually towards the integration of multi-orientation common development [3]. However, with the gradual improvement of people's living standards, the overexploitation of resources is becoming more and more serious; however, there is a limit to the pressure that the ecological environment can withstand, and the importance of environmental protection is becoming increasingly apparent. The amount of pollution in the process of clothing production is not to be underestimated; some materials, in order to ensure that the production, processing, use and other processes can be carried out smoothly, often consume a lot of chemical substances and energy, so that it is inevitable that physical or chemical changes will take place, resulting in the production of a lot of waste gas, wastewater, residue, and other kinds of environmentally harmful substances [4–7]. For example, the pollution of water by dyes during printing and

Corresponding author: Panlei Chen, mail address: 18511367741@163.com

Received: 17 October 2024; Accepted: 16 December 2024; Published: 20 February 2025

Keywords. Fashion clothing design; SIFT algorithm; hierarchical approach; BBF algorithm; affiliation function

2010 *Mathematics Subject Classification.* –

Cited this article as: Chen. P, Innovations in eco-friendly fashion clothing design based on SIFT algorithm and biomimetic materials. *Engineering and Its Applications*, 2(1), 2025, 1-12.

© 2026 Engineering Journals. Published by Engineering Journals

dyeing, the pollution of the atmosphere by harmful gases released during production, and the soil pollution caused by the disposal of garments and so on. In the face of global warming, the world's sea level will rise, many species will disappear, the environmental crisis will be a concern, and the world set off a low-carbon economy boom [8–10]. Clothing as a leading fashion is also sought after in the industry, thus kicking off the prelude to low-carbon clothing. Therefore, exploring different design methods of environmental protection concepts in clothing possesses a positive role in ecological protection as well as the future development of green clothing [11, 12].

In this paper, biomimetic materials are integrated with clothing design to realize the concept of environmental bionics. Firstly, the SIFT algorithm is used to extract the feature points of the biomimetic material by adopting the pyramid layering method, and the feature vectors of the feature points are obtained by calculating their scale and direction descriptors. Then the extracted natural elements are transformed into clothing design elements that can be applied by the BBF algorithm, and the bionic elements are fused according to the affiliation function guidance. Finally, in the practical analysis, the superiority of the design method of this paper is verified through the testing of the composition of the clothing material, the sales volume of the bionic clothing and the feedback analysis. It is proven that environmentally friendly fashion clothing designed based on biomimetic materials puts the clothing industry on the road to sustainable development.

2. Literature review

Vilumsone-Nemes, I et al. proposed to utilize cross-stripe fabrics in the production of traditional garments by using their special design and fabric, which can reduce fabric waste by keeping the length of the style in line with the fabric pattern without changing the design and visual perception of the garment style. This method helps to reduce fabric waste, material consumption, and product cost after industrial production [13]. Nupur Chopra et al. analyzed the information collected through field studies, on-site observations, and interviews with stakeholders at apparel manufacturing units and established a competency and assessment objective that could measure corporate sustainability. Based on the analysis, they also summarized the factors that hinder innovation in the apparel industry and the areas that companies need to focus on [14]. Stenton, M et al. analyzed sustainable recycled materials in the apparel and textile industry based on regenerated protein fibers to reduce waste throughout the supply chain by using textile quality, lifecycle, and product longevity as key analysis metrics in a circular fashion economy [15]. Li, X to solar warmth, energy saving, aesthetic and practical characteristics, design practical solar clothing. And through data analysis, logical reasoning and other methods from the application of solar energy status quo, in order to design point of view and development measures to enrich the field of clothing production and processing, improve market competitiveness provides a certain reference value [16]. Qin, F et al. proposed a multi-cue sensory information fusion mental model based on clothing silhouette perception, which takes human perception as the core, analyzes the research on perception design theory, and draws on the multi-cue sensory information fusion theory. Starting from the tailoring of clothing, the silhouette elements are used as an information source for the innovative design of the color, silhouette and texture of clothing. The method provides a practical approach for apparel designers to integrate color, texture and other aspects of sensory information [17].

3. Clothing bionic process

Bionics is a discipline that mimics the natural structure, function and characteristics of living things for application. The bionic design originates from bionics, which is based on the redesign and re-creation by imitating certain qualities of natural creatures, and at the same time combining with the research results of bionics to provide new principles, new methods and new possibilities for design. The application of bionic design in apparel design is not a sudden inspiration but has certain rules to follow [18–20]. Clothing bionic design can be accomplished through a series of processes such as establishing bionic prototypes, choosing bionic design perspectives, implementing specific programs, and overall improvement.

The process of clothing imitation is shown in Figure 1. Firstly, collect the bionic material and establish the prototype of the bionic. Then design the bionic angle according to the bionic form, material and function, as well as the implementation program. The extracted natural elements are transformed into clothing design elements that can be used. Trying to avoid mechanical imitation of the bionic object requires the designer to generalize and transform its morphological characteristics. Finally, the completion of each piece of finished clothing is inseparable from repeated modification and improvement. In the final stage of design, the need to shift the focus of the design from the details of the speculation to the grasp of the whole, to examine the part and part, the relationship between the whole and the part.

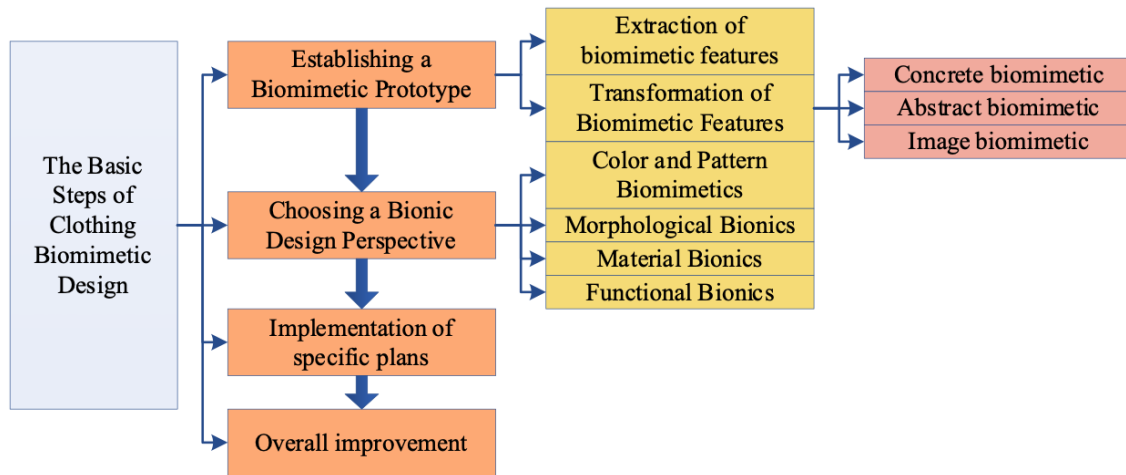


Figure 1: Steps in Bionic Design for Clothing

4. Clothing bionic model incorporating biomimetic materials

4.1. Extraction of bionic features

In the process of refining the design materials, we should make some choices and select the material elements that can be used for in-depth analysis. The natural form of the bionic object may be complex and disorderly and have many features, and the visual characteristics and psychological feelings contained in different kinds, structures and colors of natural creatures are very different. Then we need to start from a point, highlight the morphological characteristics of a certain aspect of the bionic object, and weaken the other morphological characteristics so as to achieve a prominent theme.

In this paper, the SIFT algorithm is used to obtain the feature vector and match the data. The SIFT feature point extraction algorithm mainly adopts the pyramid layering method to extract the feature points of the bionic material and get the feature vector of the feature points by calculating its scale and direction descriptors so as to carry out the matching, and the algorithm has the advantages of rotational invariance, etc.

The computation is performed using the Harris operator to obtain the key points. Harris corner point detection operator is a detection method based on the first-order derivative matrix of the image gray level. The main idea is to calculate the similarity between an image block in a certain localized window and an image block in a window after a tiny shift in each direction. Then the matrix is defined as

$$A(x) = \sum_{xy} \omega(x, y) \begin{bmatrix} c_x^2(x) & c_x c_y(x) \\ c_x c_y(x) & c_y^2(x) \end{bmatrix} = \begin{bmatrix} a & b \\ b & c \end{bmatrix} \quad (1)$$

Where c_x and c_y are the first-order derivatives of the representative intensities of the points in the x - and y -directions, respectively, and $\omega(x, y)$ is the weight of the corresponding positions of the points in the x and y -directions.

The distribution characteristics of the pixel gradient directions in the neighborhood of the feature key points are used to specify for each keypoint its orientation parameter, thus making the operator rotationally invariant.

$$m(x, y) = \left\{ [L(x+1, y) - L(x-1, y)]^2 + [L(x, y+1) - L(x, y-1)]^2 \right\}^{\frac{1}{2}} \quad (2)$$

$$\theta(x, y) = \text{atan2} \left[L(x, y+1) - L(x, y-1), L(x+1, y) - L(x-1, y) \right] \quad (3)$$

In the above equation, m is the gradient magnitude, θ is the spoke angle, and $L(x, y)$ is the image layer at the scale where the sample point is located.

The gradient magnitude and spoke angle of (x, y) are calculated using Equation (3) and Equation (2), and the histogram of the key point is counted, the histogram is counted using Gaussian weighting operation, and the peak of the histogram is the main direction of the feature point, and another secondary direction can also be found as the auxiliary direction. The coordinate sequence number of the key point and the feature operator are combined to return as a feature vector.

The scale space of the bionic material is defined as a function $L(x, y, \sigma)$ which is obtained by convolving a variable scale Gaussian function $G(x, y, \sigma)$ with an input image $I(x, y)$:

$$L(x, y, \sigma) = G(x, y, \sigma) \times I(x, y) \quad (4)$$

Where,

$$G(x, y, \sigma) = \frac{1}{2\pi\sigma^2} e^{-(x^2+y^2)/2\sigma^2} \quad (5)$$

Gaussian difference scale space $D(x, y, \sigma)$ is defined as the difference of neighboring scale Gaussian functions in the presence of a constant multiplicative scale factor k convolved with the original image, and the local extremes in these Gaussian difference images are taken to obtain the image feature points on the domain of the scale space, and $D(x, y, \sigma)$ can be expressed as:

$$D(x, y, \sigma) = (G(x, y, k\sigma) - G(x, y, \sigma)) \times I(x, y) \approx L(x, y, k\sigma) - L(x, y, \sigma) \quad (6)$$

Once the feature points are determined, next calculate the orientation for each feature point. The fitting function at the candidate feature point is obtained:

$$D(X) = D + \frac{\partial D^T}{\partial X} X + \frac{1}{2} X^T \frac{\partial^2 D}{\partial X^2} X \quad (7)$$

Derivation to obtain the extreme point $\hat{X} = -\left(\frac{\partial^2 D}{\partial X^2}\right)^{-1} \frac{\partial D}{\partial X}$ and the corresponding extreme value $D(\hat{X}) = D + \frac{1}{2} \frac{\partial D^T}{\partial X} \hat{X}$, constantly correct X to obtain the local optimal point, eliminate the weak feature points of $|D(\hat{X})| < 0.03$, and at the same time, obtain the precise location and scale of the candidate feature points.

4.2. Bionic feature matching

Transforming the extracted natural elements into clothing design elements that can be applied to avoid mechanical imitation of bionic objects as much as possible requires designers to generalize and transform their morphological features, a process known as the transformation and trade-off of bionic features.

After generating the d -dimensional SIFT feature description, the Euclidean distance is used as the similarity criterion of the multidimensional vectors to match the 2 feature points. Assuming that the generated feature descriptors of bionic materials and clothing elements are given, the Euclidean distance can be expressed as follows:

$$d = \sqrt{\sum_{i=0}^{d-1} (Re_{i1}(x_{u1}) - Re_i(x_{2li}))^2} \quad (8)$$

The BBF algorithm is then used to search for the 2 nearest and second nearest neighbor feature points of each feature point of the bionic material and the mismatch relationship by comparing the nearest and second nearest neighbor distances. Assuming that the 2 nearest and next nearest Euclidean distances to feature point E are P and P' respectively, and calculating the ratio of the Euclidean distances of the feature point E to those of feature points P and P' of the matching garment, if the ratio value of the distances is less than a certain threshold value of T , then the matching is considered to be successful.

However, if the amount of combinatorial computation is very large, an appropriate number of samples k can be determined to ensure that, at this point, the probability that the data needed for model estimation are all interior points is sufficiently high. Let w denote the probability that one of the selected data points is an interior point, and z denote the probability that at least one of the randomly selected data points will be error-free n after sampling is performed, then the minimum number of samples k that need to be performed is determined by the following equation:

$$z = 1 - (1 - w^n)^k \quad (9)$$

Where w^n denotes the probability that all data are interior points, $1 - w^n$ denotes the probability of failure after 1 sample, and $(1 - w^n)^k$ denotes the probability of failure after k samples. That is:

$$k = \frac{\log(1 - z)}{\log(1 - w^n)} \quad (10)$$

Determine a bionic element data set P consisting of N data points and assume that the vast majority of these N data points are generated by a specific bionic material model with unknown parameters that requires at least n data points to solve and $N > n$. A subset S of n data points is randomly selected from P and a model M is computed from these n selected data points. Record the number of data points c in P that are within some error allowance of M . After iterations 1-3 k , the model corresponding to the maximum value is the desired one.

5. Eco-fashion clothing design

5.1. Fusion of fashion elements

From the perspective of fashion, the imitation of bionic clothing can start from the two aspects of color images and material elements and choose the appropriate bionic method to express the design elements according to the needs of clothing design. For the fusion of bionic materials and clothing, this paper adopts fuzzy logic fusion rules to guide the fusion of bionic elements. The set composed of all the studied anti-bionic material elements is U , and U is called the thesis domain. For the fuzzy set A of elements x , x in the thesis domain, i.e:

$$A = \{x, \mu_A(x) \mid x \in U\} \quad (11)$$

In Equation (10), $\mu_A(x)$ is the affiliation function of the fuzzy set A , $\mu_A(x)$ is called the affiliation of x to the fuzzy set A , and the mapping interval of the affiliation is a continuous variation between 0 and 1.

By applying the Gaussian affiliation function as a weighting coefficient to the image fusion criterion, the expression of the Gaussian affiliation function is:

$$f(x; \mu, \sigma) = \exp \left\{ -\frac{1}{2} \left(\frac{x - \mu}{\sigma} \right)^2 \right\} \quad (12)$$

Where μ represents the center of that function and σ is usually positive and determines the width of the function.

Regarding the fusion of clothing colors, the fusion of color images is achieved through an *IHS*-space model, in which the luminance I , chroma H , and saturation S are relatively independent in the *IHS*-model. The chroma component and saturation component are determined based on the fused luminance component, thus reducing the computation of the algorithm and the uncertainty of the fused image discoloration and distortion. Assuming that the garment images used for fusion have been strictly spatially aligned, the color image is *IHS* transformed, and the transformation formula is shown below:

$$\begin{bmatrix} I \\ V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 1/3 & 1/3 & 1/3 \\ -1/\sqrt{6} & -1/\sqrt{6} & 2/\sqrt{6} \\ 1/\sqrt{6} & -1/\sqrt{6} & 0 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (13)$$

$$H = \tan^{-1}(V_2/V_1) \quad (14)$$

$$S = \sqrt{V_1^2 + V_2^2} \quad (15)$$

The luminance component, chrominance component and saturation component of the color image are obtained by *IHS* transform, respectively, and the low-frequency part and high-frequency part of the luminance component are obtained by multi-scale decomposition of the luminance component I through the non-downsampling transform, respectively.

For the uncertainty of the degree of information incorporated into the source image in the image fusion process, for the color of the low-frequency sub-part, this paper determines the fusion adaptive weighting coefficients of the image by the adaptive weighted average fusion criterion of fuzzy logic, using the Gaussian affiliation function:

$$\eta_0(i, j) = \exp \left[-\frac{(C(i, j) - \mu)^2}{2(k\sigma)^2} \right] \quad (16)$$

$$\eta_1(i, j) = 1 - \eta_0(i, j) \quad (17)$$

In the above equation, μ denotes the low-frequency subband image pixel mean, σ denotes the low-frequency subband image pixel variance, and k is a constant. Then the low frequency fusion rule is:

$$C_F(i, j) = \eta_0(i, j)C_A(i, j) + \eta_1(i, j)C_B(i, j) \quad (18)$$

In the above equation, $C(i, j)$ represents the low-frequency subband coefficients at pixel point (i, j) . The Gaussian affiliation function is used to determine the weighting coefficients for fusion for the low-frequency portion of the garment color, and the low-frequency subband portion of the image to be fused through the non-downsampling transform retains most of the main information of the luminance component of the image to be fused, and the adaptive weighting coefficients can better retain this important information.

The high-frequency subband image contains most of the detail information and texture feature information of the image to be fused, which is manifested as high-frequency coefficients with large absolute values, and after N -stage non-downsampling decomposition, it can be decomposed into different directions at j scales, and each direction can only embody the detail information in that direction, so the high-frequency subband fusion coefficients are determined by comparing the magnitude of the absolute values of subband coefficients of each direction at different scales, i.e:

$$C_{F,j}^d = \max \{ C_{A,j}^d, C_{B,j}^d \}, \quad d = 1, 2, \dots, 2^j \quad (19)$$

Where, 2^j denotes the number of orientation decompositions at the j scale, and $C_{A,j}^d$ and $C_{B,j}^d$ denote the d orientation sub-band coefficients of the images to be fused A and B at the garment j scale, respectively.

Fuzzy logic provides a precise description of the fuzzy concept of bionic material elements by means of an affiliation function, which is flexible, simple, easy to understand, and inclusive of imprecise data. In the

field of clothing color image fusion, the relationship between corresponding pixels of different target scenes and bionic elements has uncertainty, and this uncertainty can be quantitatively described by defining a fuzzy affiliation function, which is used to fuse different bionic materials and colors for different clothing types.

5.2. Clothing design process

According to the bionic model of clothing, this paper categorizes and quantifies the popular elements related to the clothing design process. Figure 2 shows the design process of eco-friendly fashion apparel, in which apparel designers combine domestic and international published trend forecasts with their own subjective analysis to determine the results of the analysis of popular elements that need to be specifically reflected in the final design results. Then, determine the parameters in the prediction model, which includes which data segments in the historical database are used for prediction, the rotation cycle of each popular element, trend analysis, etc. A complete design plan mainly includes clothing shape, style, style, accessories, colors, fabrics, patterns, matching design of apparel and so on. At the same time, structural design, size determination, etc., should also be carefully and rigorously considered.

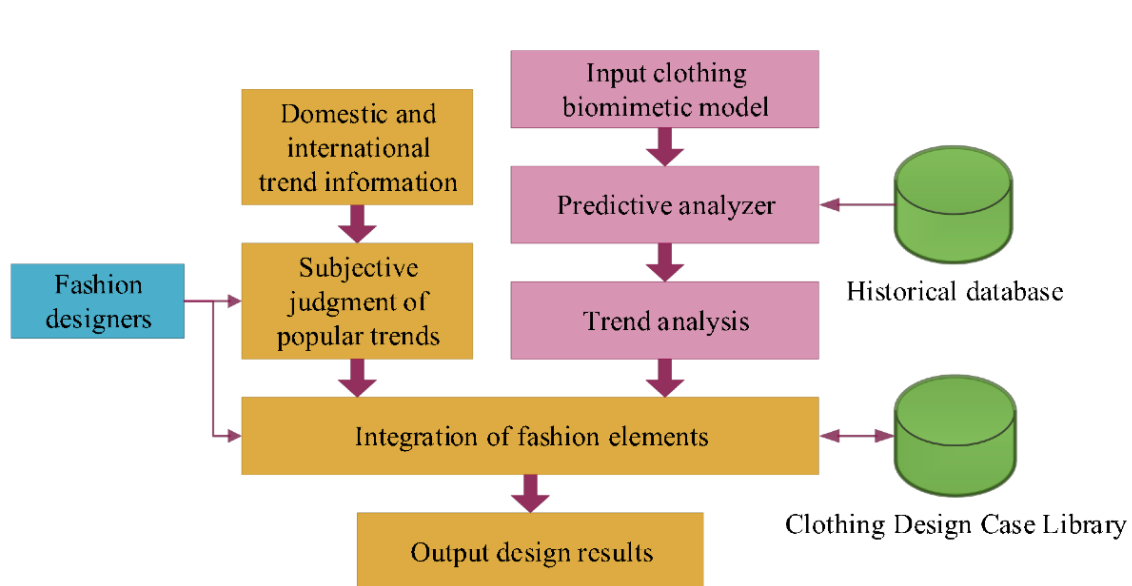


Figure 2: Eco-friendly fashion clothing design process

The material of clothing is the main content of design, and this paper uses bionic materials to emphasize the expression of the beauty of the external form of living creatures. In the process of apparel design, designers summarize and refine the morphological elements of living creatures in nature and express them in apparel design with certain artistic techniques, seeking breakthroughs and innovations in apparel materials. The surface texture and texture of natural organisms is not only a tactile or visual appearance but also an external expression determined by the inner function. Clothing is designed using bionic, not only in the shape of its inexhaustible external form but also a constant stream of inspiration on the color. The material can perform amazing functional innovation so that clothing design is more creative and challenging to meet the needs of human emotional expression, give the clothing life and cultural connotation, and enhance the harmony of mankind and the natural world.

6. Practical analysis of eco-fashion clothing models

6.1. Clothing material composition testing

Clothing material is an important factor in clothing design, applying bionic material to clothing design so that it can play the same or similar function in people's daily use or wearing process. In order to verify whether the eco-friendly fashion clothing designed in this paper is in line with the green concept, five different types of bionic clothing are designed through this model. During the production process, the effluent discharged from them is collected, and the effluent composition is tested to assess whether it meets environmental protection standards. Table 1 shows the results of the sewage composition assessment, and this paper produces five different types of costumes made of different materials. Among them, automatic sewage apparel utilizes the soluble characteristics of lotus leaf surface keratin, which can take away the attached dirt particles in the apparel and improve the superhydrophobic or oleophobic ability. Pressure-sensitive apparel adopts mimosa and other organisms with driving functions, and through the special structure of its leaf pillows and polymer material fusion, it becomes wearable, realizing a touch-sensitive driving function. Low-friction antimicrobial apparel is made of sharkskin bionic material to make swimsuits and other antimicrobial apparel, while antistatic apparel and ultraviolet ray prevention apparel are made of bionic material such as light-sensitive fibers from silkworms and green algae, respectively. The above bionic clothing in the production process, including silk products, the amount of sewage of at least only 22mg/L, green algae sunscreen clothing sewage discharge amount of 33mg/L, but also to meet the sewage discharge standards, to achieve the concept of low-carbon environmental protection. It can be seen that this paper uses bionic materials made of clothing to make rational use of natural resources to make the clothing industry on the road to sustainable development, to promote the development of ecological economy and ecological civilization, to achieve the coordinated development of human society and the natural environment.

Table 1: Clothing composition assessment results

Biotechnology	Extracts	Type of clothing	Sewage Discharge
Lotus leaf	Page Exfoliation	Sewage clothing	30mg/L
Sensitive plant	Leaf Pillow Principle	Pressure-sensitive clothing	28mg/L
Aquatic animal	Sharkskin	Low friction antimicrobial clothing	25mg/L
Peas	Natural silk	Anti-static clothing	22mg/L
Chlorella	Light-sensitive fiber	UV protection clothing	33mg/L

Children's clothing has become the focus of competition for clothing companies because of the special nature of the object used, but safety is more important than any other aspect. For this reason, this paper selects two textile factories, A and B. Factory A utilizes ordinary textile materials to design children's clothing, and factory B utilizes biomimetic materials of biology to produce children's clothing, respectively; from the two factories, 80,000 children's clothing samples are randomly selected into 8 groups, and formaldehyde content in the clothing, clothing odor, PH value and so on, are measured and qualified children's clothing are statistically counted as a way of verifying the safety and quality of the production of the two factories. The results of the qualified rate statistics are shown in Figure 3. In the testing of children's clothing samples in Factory A, it can be seen that the passing rate of the quality of children's clothing in this factory is not very stable, the passing rate of Group 6 reaches 63%, but the passing rate of children's clothing samples in Group 2 and Group 8 is only 45% and 44% respectively. In the testing of children's clothing in Factory B, the pass rate of each group of samples exceeded 80%, of which the pass rate of Group 5 was as high as 92%. This can be illustrated by the children's clothing quality pass rate more strongly verifies the safety of bionic materials and environmental protection so that the garment industry as soon as possible from the high consumption of resources and high pollution to low-carbon emission reduction and environmental protection type of transformation and timely advocacy of consumer awareness and behavior of low-carbon consumption.

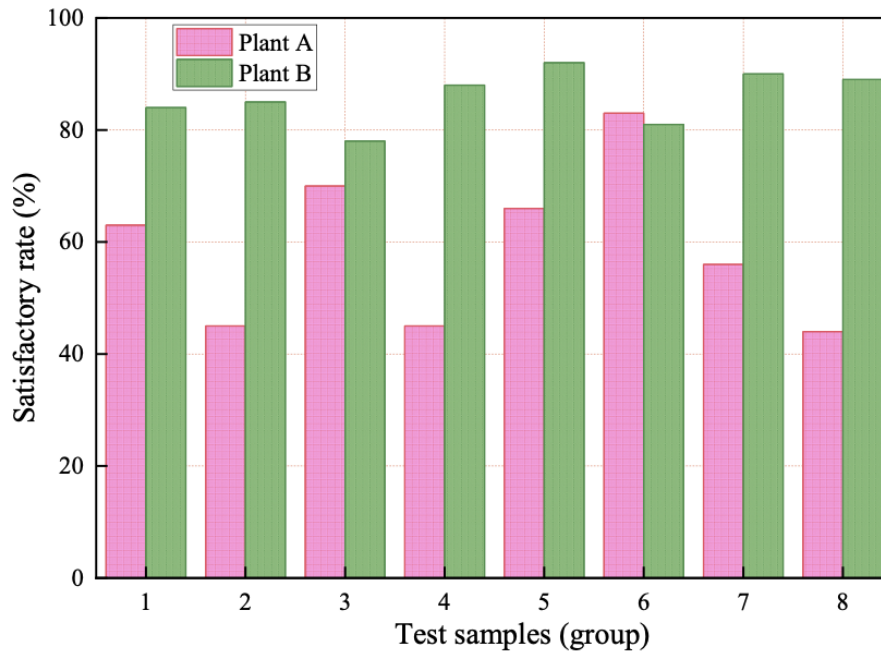


Figure 3: Statistical results of pass rate

6.2. Bionic clothing sales volume

Based on the biomimetic material design apparel not only to meet the standards of low-carbon environmental protection but also to meet the public aesthetic vision, this paper selects A, B two textile factories, A factory using ordinary textile materials for the design of clothing, B factory using biomimetic materials, and through the image fusion technology on environmental clothing patterns and color elements for the design and mixing. By comparing the sales volume of garments of the two factories in the past seven years in order to verify the superiority of the design method of this paper, the comparison results are shown in Figure 4.

Figure 4(a) shows the sales of clothing in factory A. The clothing materials in factory A are mainly polyester, synthetic fibers, cotton and linen, and tweed, which are four traditional production materials. Among them, the sales volume of garments made of polyester and linen is higher, reaching a maximum of 860,000 pieces and 770,000 pieces, respectively. This is because polyester and linen are fabrics preferred by the garment industry, but polyester is poorly dyed, so it needs to consume a lot of pigments and a lot of chemical residues and wear harmful to the human body. The linen material is a natural fiber, and the fabric does not require a lot of chemical processing and energy consumption, but the stability is poor, easy to absorb bacteria and grease. Therefore, as people's requirements for clothes improve, polyester and linen sales fell by about 38% due to lower demand, and synthetic fibers and tweed sales are lower, an average of not more than 500,000 pieces per year.

Figure 4(b) shows the sales of clothing in Factory B. The factory uses biomimetic materials for the innovative design of fashionable clothing, so the acceptance of clothing made of this material was low at the beginning, and the sales of pressure-sensitive clothing made from the leaf pillows of mimosa were less than 300,000 pieces, as well as the automatic sewage garments only amounted to 330,000 pieces. However, as people's aesthetics changed and demanded more comfort, they demanded higher quality in fashionable clothing, so Factory B's sales gradually increased, and by the seventh year, sales of the five types of bionic eco-friendly clothing exceeded 500,000 pieces per year. Among them, the sales of anti-static garments made of silk bionic materials reached a maximum of 1.45 million pieces per year, while spinning garments

made of light-sensitive fiber bionic materials from green algae, which were also more popular, ended up with sales of more than 1 million pieces. It can be seen that environmentally friendly clothing based on biomimetic materials not only satisfies the concept of environmental protection but also meets the needs of public aesthetics.

6.3. Feedback analysis of bionic clothing

In the design of clothing, it is necessary to design and innovate according to the characteristics of different buyers. In order to verify whether the bionic clothing designed in this paper is in line with the fashion style, this paper analyzes the feedback of buyers of different age ranges and the frequency of wearing clothes statistically and optimizes and corrects according to the results of the analysis. Table 2 shows the results of the feedback analysis of the bionic clothing. More than 75% of the buyers in different age ranges said that they wore the clothing designed with bionic materials almost every day and said that the comfort of this clothing product is better and meets the needs of the public. It shows that the integration of biomimetic materials in clothing design in this paper not only advocates avant-garde design concepts but also possesses more practical and fashionable features, prompting more people to accept environmentally friendly clothing.

Table 2: Results of feedback analysis of bionic clothing

Age range	Comfortableness	Wear it every day	Wear 1 time a week	Wear 1 time per month
3–13 years old	Comforts	78%	18%	4%
19–50 years old	Very comfortable	83%	17%	0
Over 50 years old	Comforts	80%	20%	0

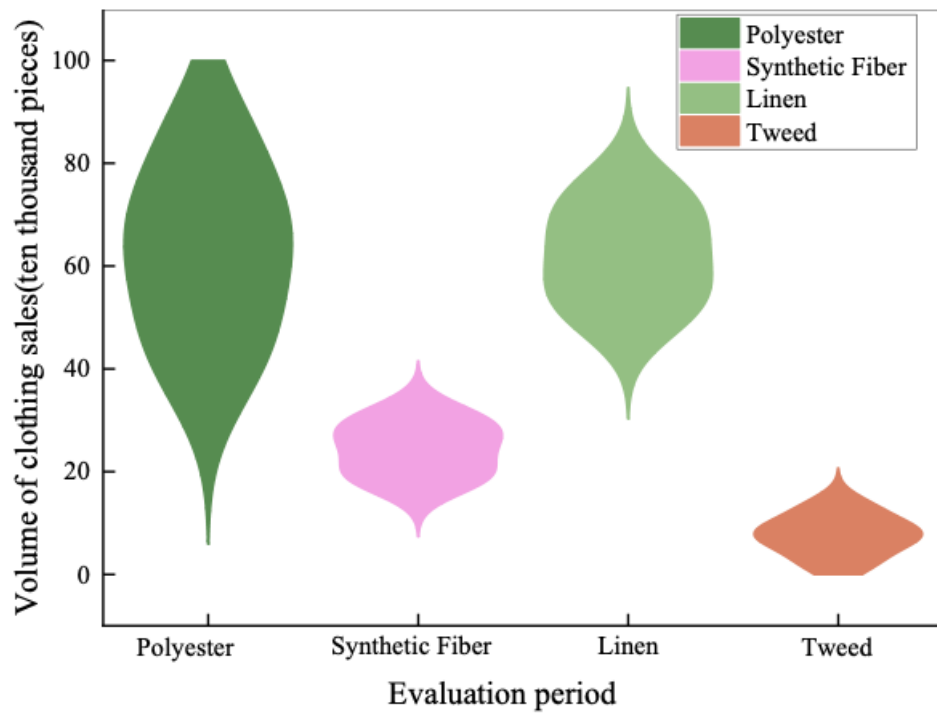
7. Conclusion

This paper realizes the innovative design of environmentally friendly fashion clothing through the integration of biomimetic materials. In order to verify the rationality of the design method, this paper analyzes its environmental friendliness and fashionability in practical analysis. The conclusions are as follows:

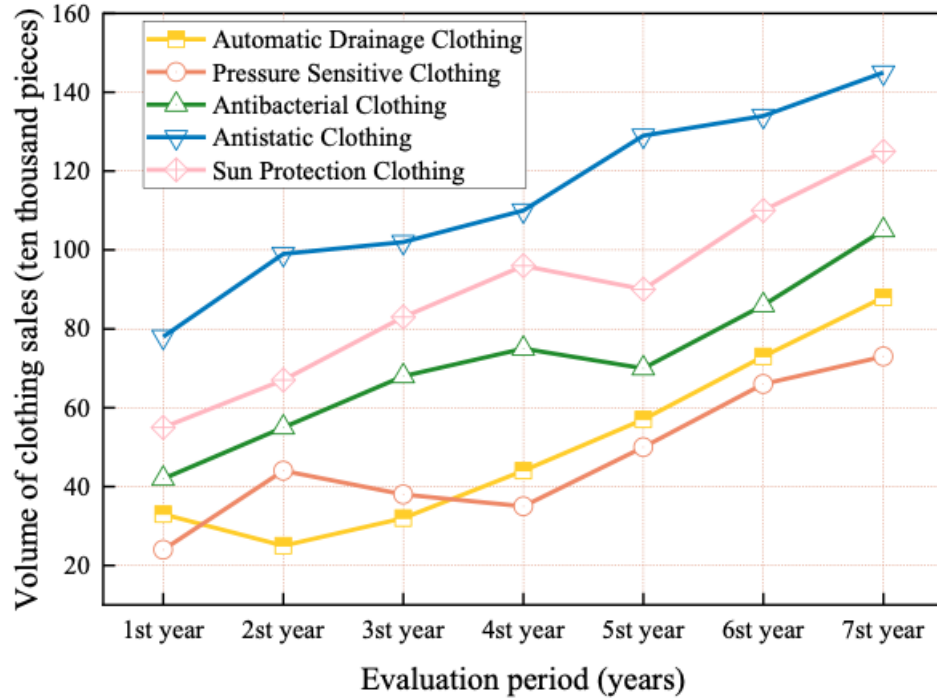
1. In the clothing material composition test, the bionic clothing designed in this paper produces less than 50mg/L of sewage content, which meets the sewage discharge standard. And the pass rate of each group of samples of children's clothing is more than 80%, which verifies the safety and environmental protection of the bionic material so that the clothing industry can complete the transformation from high resource consumption and pollution to low-carbon emission reduction and environmental protection as soon as possible.
2. Regarding the sales volume of garments and feedback analysis, compared with traditional textile materials, the sales volume of garments designed with biomimetic materials has gradually increased, reaching a maximum of 1.45 million pieces per year. And more than 75% of the buyers in different age ranges said that they wear clothing designed with biomimetic materials almost every day, which indicates that the clothing designed in this paper has the characteristics of being more practical and fashionable.

References

- [1] Chen, W., & Wu, Y. (2021). China's new environmental protection law and green innovation: evidence from prefecture-level cities. *Complexity*, 2021(36), 1-13.
- [2] Gao, J. (2017). 3d-model-based impact of eco-friendly design concepts on industrial design. *Revista de la Facultad de Ingenieria*, 32(11), 468-473.



(a) Sales of garments in factory A



(b) Sales of garments in factory B

Figure 4: Sales Volume Comparison Results

- [3] Yang, C., Zhou, Y., Zhu, B., Yu, C., & Wu, L. (2021). Emotionally intelligent fashion design using CNN and GAN. *Computer-Aided Design and Applications*, 18(5), 900-913.
- [4] Dong, Y., Yang, J., Hu, P., & Chou, L. (2019). A study on the relationship between economic production performance and pollution in Chinese coastal cities: an analysis of the undesired output. *Journal of Coastal Research*, 96(sp1), 21-25.
- [5] Santos, D. K. M., & Shimada, K. (2021). Environmentally-friendly agriculture on rice production in Shiga, Japan. *Chemical Engineering Transactions*, 83, 319-324.
- [6] Ibrahim, I., Deva, N., & Muqolli, S. (2021). Integrated dry granulation – possibility of reducing environmental pollution and valorization of Fe-Ni slag. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, (3), 25-30.
- [7] Yin, B. (2017). Dynamic econometric analysis of the spillover effect of environmental pollution loss by using spatial object model. *Boletín Técnico/Technical Bulletin*, 55(4), 669-679.
- [8] Hong, Y. (2022). Application of convolution neural networks-based hierarchical perception technology in 3D clothing designs. *IET Networks*, 11, 257-263.
- [9] Yang, R., & Liao, Z. (2018). The research skeleton of global low carbon economy: the rise of green development and the transformation of paper industry. *Paper Asia*, 1(9), 26-29.
- [10] Liu, J., & Li, G. (2017). Research and construction of enterprises environmental accounting system under low carbon economy background. *Revista de la Facultad de Ingeniería*, 32(12), 382-387.
- [11] Mañas, L., Rusnáková, S., Javořík, J., Aludek, M., & Fojtl, L. (2019). Verification of material composition and manufacturing process of carbon fibre wheel. *Manufacturing Technology*, 19(2), 280-283.
- [12] Alegoz, M., Kaya, O., & Bayindir, Z. P. (2021). A comparison of pure manufacturing and hybrid manufacturing-remanufacturing systems under carbon tax policy. *European Journal of Operational Research*, (8), 161-173.
- [13] Vilumsone-Nemes, I., Kaplan, V., & Belakova, D. (2020). Potentialities of reducing textile waste in the manufacturing of garments from striped fabrics. *Fibres and Textiles in Eastern Europe*, 28(6), 58-63.
- [14] Chopra, N., & Singh, M. (2019). Mapping the environmental sustainability practices in a garment manufacturing unit, a case study analysis to identify inhibitors. *International Journal of Textile and Fashion Technology*, 9(4), 11-18.
- [15] Stenton, M., Kapsali, V., Blackburn, R. S., & Houghton, J. A. (2021). From clothing rations to fast fashion: utilising regenerated protein fibres to alleviate pressures on mass production. *Energies*, 14(18), 5654.
- [16] Li, X. (2017). Application status and design and development of solar energy clothing. *Revista de la Facultad de Ingeniería*, 32(14), 616-622.
- [17] Qin, F., Kuang, C., & Jiang, Y. (2020). Multiple-clue sensory information fusion model of fashion silhouette perception in coastal city. *Journal of Coastal Research*, 104(sp1), 891-895.
- [18] Wu, Z., Huo, Y., Ding, W., & Xie, Z. (2018). Bionic shape design of electric locomotive and aerodynamic drag reduction. *Archives of Transport*, 4(48), 99-109.
- [19] Zhou, Q. (2018). Clothing accessory design based on sensory experience. *NeuroQuantology*, 16(6), 460-465.
- [20] Xu, Y., Liu, L., Yuan, L., Liao, Y., & Li, X. (2017). Enhancement on the composite electromagnetic and mechanical property based on the bioparticle and bionic design. *Polymer Composites*, E73-E81.